Mechanical World

AND ENGINEERING RECORD

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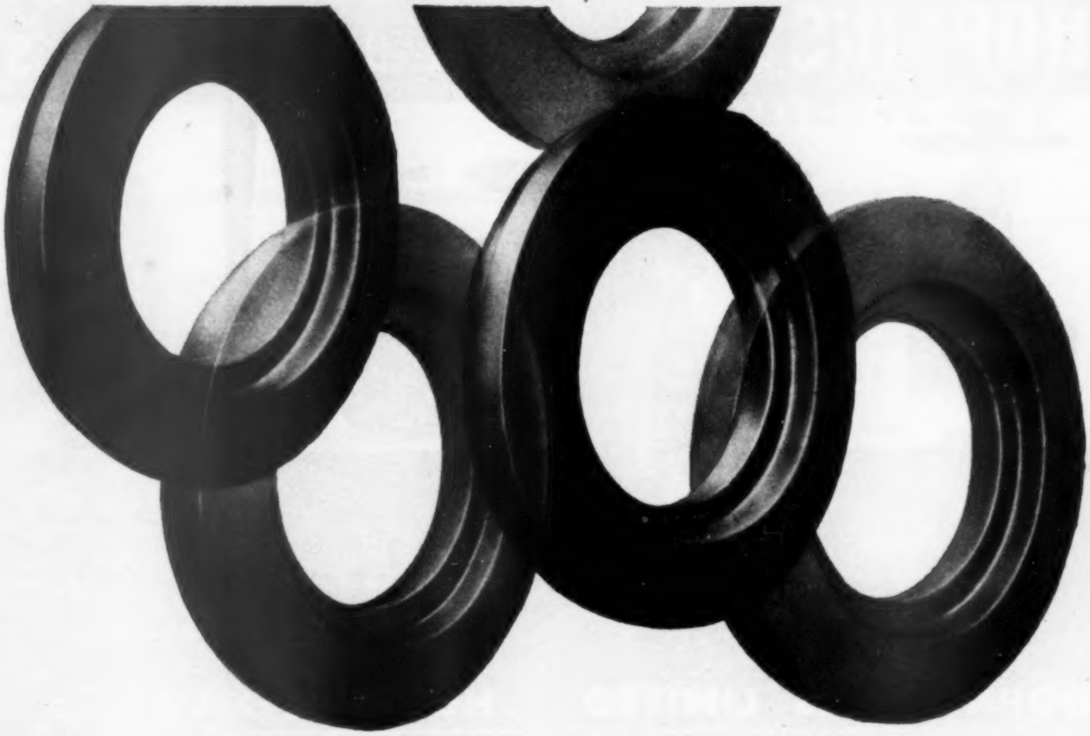

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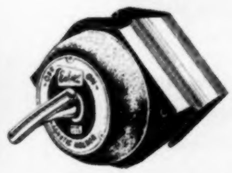

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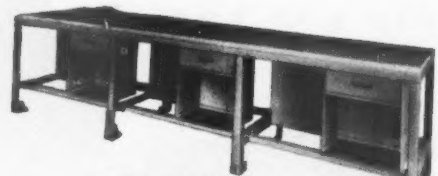

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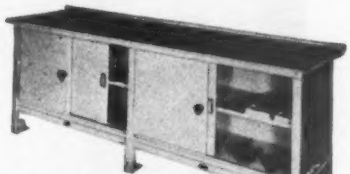

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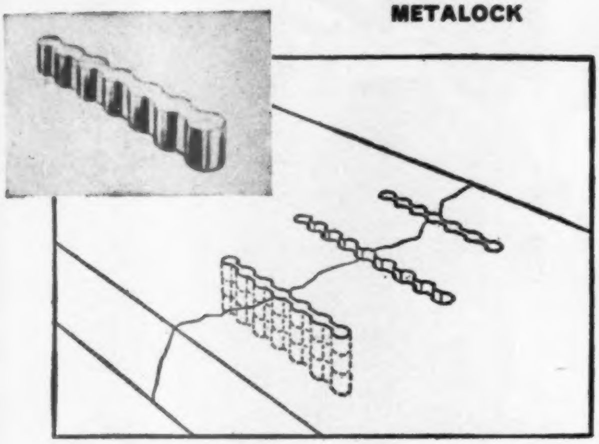

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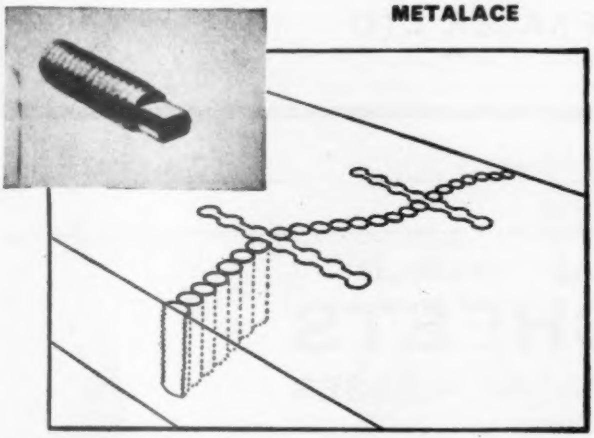

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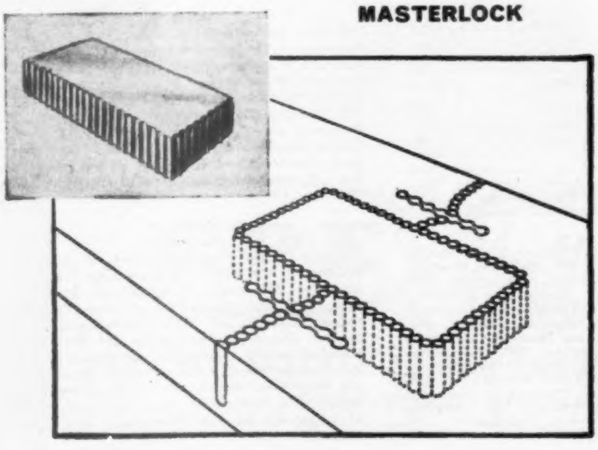

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Mechanical World

AND ENGINEERING RECORD

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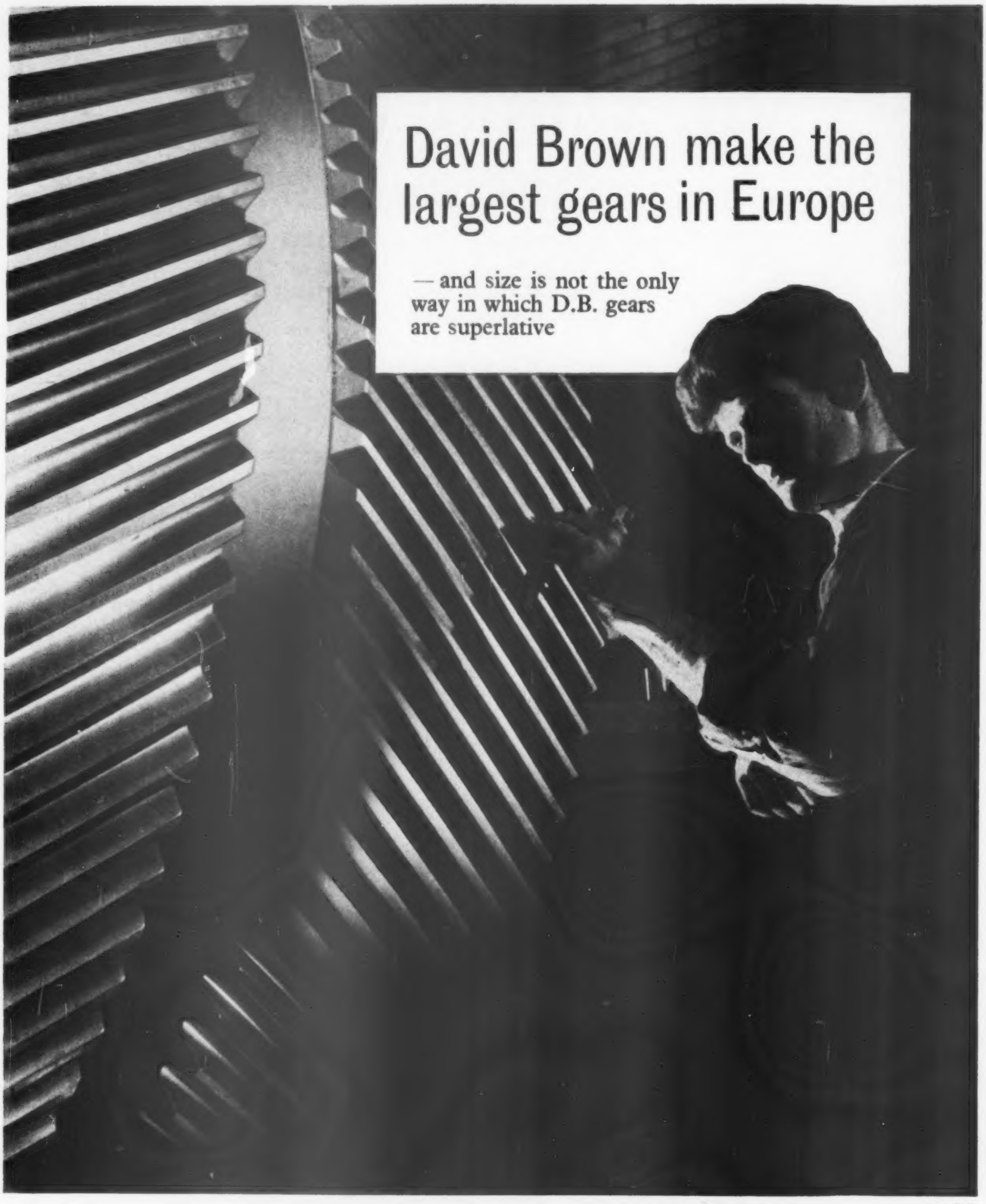
Contributions. The Editor invites original contributions on mechanical subjects. Broadly the aspects covered are the design, materials, manufacture, process, management and maintenance of engineering and industrial plant and machinery. Sketches may be in pencil. Photographs are welcome and so are short notes of practical experience. Payment is made for exclusive contributions. Communications should be addressed: The Editor, MECHANICAL WORLD, 31 King Street West, Manchester 3.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Mechanical World — November 1962

Factory Picture

IF industrial experience at any one time were averaged into one imaginary factory the circumstances of the establishment would presumably be deducible from the F.B.I. enquiry for the corresponding period. Not all essayists at this exercise in jobbing backwards would get the same result. Each picture would have something in it of its author's own experience. We propose to make the attempt here and now from our own relatively (we hope) detached viewpoint.

The work of the factory is almost half mechanical engineering in character, rather less than one quarter being tooled-up flow production and another being largely separate jobs of greatly varying size. The other half uses almost every workable material for every conceivable purpose. There are some 1000 employees and it is much easier than formerly to get labour for about half the trades, though in two or three trades it is not easy to find the right people. More than half the factory continues to be steadily employed and the order books for these sections are good. Order books for about a fifth of the products made are expanding somewhat, but another fifth shows some contraction and there is consequently some concern about the future of these sections.

Looking through the shops it is apparent that two-thirds of the machinery is working below capacity, and while some of this is showing signs of again getting into full swing, rather more is just about keeping station, but the largest fraction has a somewhat uncertain immediate future.

As to capital expenditure, new building is only about a third of what is being discarded, and while one-fifth of the plant is having more than is usual in the way of new machinery, renewals in two-fifths have been cut back and the rest are carrying on with their existing installations.

Unit costs are down for a tenth of the products and for the remainder as many have gone up as have remained steady. Selling prices have remained steady for two-thirds of the products and of the remainder as many have gone down as have gone up. Profit margins are down on half the output and have been increased on only some seven per cent. The main anxiety is with getting orders, and by comparison, labour, plant and finance are of little concern.

The picture one gets is of a factory staff working hard to maintain and sell output, and though not at the point of having to make both ends meet, yet is far from complacent and care-free.

The F.B.I. report does not of course visualize an imaginary factory: the view is of industry as revealed in the answers to a questionnaire and their conclusions with our one-factory picture in mind are interesting. Here they are, but very much condensed:

The economy needs stimulation—rather more than the government has recently announced. A higher level of investment is needed, and is critical to the point of disadvantage in balance of payments. In short, factory development and re-equipment are necessary to a healthy economy irrespective of how it is assailed from without, and no interruption should be permitted in the pursuit of lower costs through efficiency.

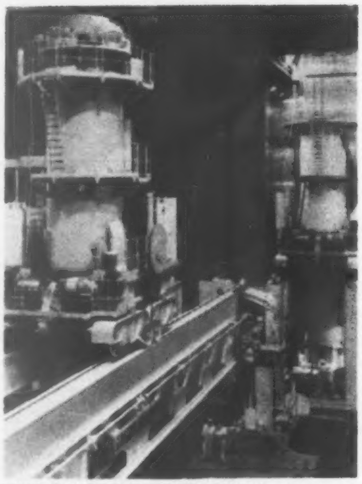
LOG SHEET

Steel Castings

An event in the "Steel Foundry Year" organized by the Steel Founders' Association to commemorate the installation in 1862 of the first furnace specifically for producing steel castings, was the Open Day held in September by Samuel Osborn & Co. Limited, when their Rutland and Holbrook Works were visited by a large party representative of every aspect of interest in steel castings. Between them these two foundries produce castings of all kinds in weights ranging from a few ounces to twelve tons, and in carbon, low alloy, austenitic manganese, stainless and heat resisting steels, and serving industries such as cement manufacture, quarrying and mining, power generation, excavation and earth moving, oil refining, brickmaking, chemical manufacture and the manufacture of iron and steel.

The main difference between the Rutland and Holbrook works is that between heavy and light castings and the differences in the modern methods appropriate to each. At the Rutland works there are extensive facilities for economical manufacture of castings singly or in quantity from the relatively small to the large sizes, with ample mechanical aids to suit size and quantity, and all co-ordinated in an efficient organization which is clearly evident in the steady flow of a large tonnage of great variety passing steadily through all the various processes, including, for some orders, extensive machining. At the Holbrook Works the speciality is precision casting by shell moulding and by the Osborn/Shaw, and Osborn CO_2 block processes. "Socast" steel castings from this model establishment again go into a great variety of products, including food preparing machinery and catering equipment, dairy-equipment, brewing and chemical plant, aircraft, shop fittings and a host of applications where high duty material is required in thin sections and to accurate form and with superior cast surface finish. Since our last visit to this plant (*MW* August, 1958) it has been extended to double the original output.

The Osborn Group now comprises 21 companies, seven of them overseas, and employs nearly 3000



FUEL HANDLING AT BRADWELL.—Two of the four charge/discharge machines at Britain's second commercial nuclear power station at Bradwell, Essex. Each is 55 ft high and weighs 400 ton. Strachan and Henshaw Limited has been responsible for the design, construction and installation of all the equipment for handling fuel into and out of the reactors.

people in the six Sheffield works. The group makes tool steels, stainless steel, alloy steels, steel castings, steel forgings, engineers' tools, valve steels for internal combustion engines, special high permeability irons for electrical plant and stainless steel fabrications and furnaces for all kinds of metal heat treatment.

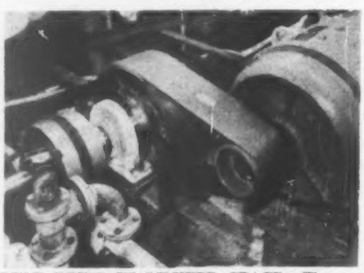
Productivity Aid

To implement the basic concept of National Productivity Year, Mr. W. Atkinson Adam, Managing Director of the Yale & Towne Manufacturing Company, Willenhall, as a move for greater productivity within the company's British manufacturing divisions, has introduced new techniques of manufacture and management in development, production and marketing department. By selective re-organization and reduction of overhead expenditure, a more efficient working unit has been developed, and streamlining the production and marketing function has added strength, due to the elimination of uneconomical activity.

Mr. W. Atkinson Adam has formed the Yale productivity team to advise management on mechanical handling problems. The team will be available to offer advice on materials handling problems and better productivity from existing facilities by planned materials movement. It consists of a field force of 20 materials handling engineers and 15 work study and process engineers and provides a comprehensive service to companies wishing to improve their efficiency and profitability.

While Yale are best known to the public as lock makers since 1870, they are widely known in industry throughout the world as producers in the materials handling field since 1898.

Mr. W. Atkinson Adam has recently joined Yale & Towne in Britain from his own engineering, marketing and manufacturing company on the Continent.



BELT DRIVE IN LIMITED SPACE.—The new M. T. "Ross Curlew" (built recently by Cochrane & Sons Limited, Selby, for the Ross Group, Grimsby) has a "Poly-V" drive fitted from the engine fore end extension shaft to a 63 kW generator. The very short drive centres (29½ in.) has been achieved by the installation of 'M' Section 26 rib belt. The driving pulley is 26.7 in. p.d. and driven pulley 10.0 in. p.d. The belt was manufactured by Turner Brothers Asbestos Company Limited, Rochdale, and the whole drive engineered and supplied by William Kenyon & Sons (Power Transmission) Limited, Dukinfield, to Drypool Engineering and Dry Dock Company Limited, Hull

Double-shell Storage Sphere

What is thought to be the largest liquid double-shell storage sphere ever built has been designed and built by Whessoe Limited and is in service at the Fawley Refinery of The Esso Petroleum Company Limited for the storage of liquid ethylene in connection with the pipeline scheme for supplying the I.C.I. works at Severnside. The inner storage sphere is of an aluminium-magnesium alloy and has an inside diameter 62 ft. This gives it a total volume of 125 000 cu ft and when full, a total ethylene load of about 1700 ton contained at a working temperature approaching $-155°$ F. This is equivalent to 60 million cu ft of gas at 60° F and atmospheric pressure.

The aluminium sphere is surrounded by a mild steel sphere, polygonal in plan and 67 ft 6½ in. mean dia. This provides an interspace between the two shells which is filled with an expanded mineral insulant in a nitrogen atmosphere.

Articulated Pressure Suit

Lightweight Nylatron and high tensile aluminium ballraces have been used extensively on the "Windak" fully pressured high altitude flying suit designed and made by Baxter, Woodhouse and Taylor Limited, Poynton, Cheshire. Developed specially to allow maximum ease of movement both in the pressurized and unpressurized conditions, the races are fitted between suit and helmet, joints of shoulders, arm, wrists, and boot tops. Incorporating a silicone rubber seal, the ballraces are only ½ in. section with a quick-release self locking toggle fastener.The neck and shoulder races are made from high tensile aluminium alloy and the smaller races at wrist, knee and calf are made in Nylatron which has the advantage of strength, light weight, and very low thermal conductivity.

Jodrell Mark II

The new 125 ft dia radio telescope to be erected at Jodrell Bank, Cheshire, beside the present 250 ft dia instrument, will have a tracking speed several times that of the latter. It will have two single drives, one for elevation and the other for azimuth and the control system will be similar to that on the Post Office installation at Goonhilly Downs. The Brush Electrical Engineering Company Limited are making the drive, servo and control system for the Mark II telescope: they also made the same equipment for the other two instruments.

A new Ferranti Argus 100 computer is to be used in conjunction with the guidance and control gear of the new radio telescope. So far as is known this will be the first time that a digital control computer will be directly connected to a radio telescope to exercise continuous control over its movements. Another of the computer's functions will be to log astronomical data obtained with the telescope, which will then be passed by data link to the Atlas computer at Manchester University for interpretation. The new computer is a fully serial version of the Argus 200 machine recently installed at I.C.I. Fleetwood to control a chemical plant, and shortly to be delivered to the C.E.G.B.West Thurrock power station to control a Babcock & Wilcox steam-raising plant. Argus is also in quantity production for a military missile programme.

Argus 100 is priced at about £27,000 for the basic 4,000 word core-store machine. The word length is 24 bits; it has an addition time of 72 microseconds and a multiply time of less than 2 milliseconds. Special interrupt facilities are included to provide a powerful on-line control capability.

The design and construction of the telescope will be under the direction of Messrs. Husband and Company.

Model of the new radio telescope to be installed at Jodrell Bank during 1963

Clean Ropes

To comply with the need for absolute cleanliness in the manufacture of ropes for the Atomic Energy Authority and nuclear power stations, British Ropes Limited have installed a "clean area" shop in their factory at Retford, believed to be the only one of its kind in existence.

There is a process specification of "clean air" conditions, prescribed by U.K.A.E.A. as a general standard, which has to be maintained in the manufacture of component parts required for nuclear power stations or similar nuclear requirements. The specification is intended to be used to eliminate the use of incompatible materials (of which there is a formidable list) as these are often considered dangerous when contaminating wire ropes or such component parts, which are in close proximity to the reactor. At first, British Ropes solved this unusual production problem by making ropes for the Atomic Energy Authority inside a polythene tent.

The new "clean area" shop is painted with Kemobel chemical resistant paint, and the site is isolated from other equipment in the factory. The operatives always wear cotton gloves, plastic overshoes and special overalls while at work. Assemblies are cleaned in tri-chlorethylene and packed in polythene containers.

Foil Rolling

A rolling mill is to be installed shortly at the works of James Booth Aluminium Limited, at Kitts Green, Birmingham. Built by The Loewy Engineering Company Limited, it is an 11 in. and 34 in. × 62 in. four-high cold type which will reduce aluminium and aluminium alloys in all tempers from an initial thickness of 0.026 in. to 0·0005 in. (single rolling) or 0·00025 in. (double rolling). A feature will be an X-ray gauge thickness control unit which will enable foil to be rolled to high tolerance limits of overall thickness. Maximum strip width at entry is 58 in. and rolling speeds are variable up to 2,900 ft per min. This non-reversing, hydraulically loaded mill will accommodate coils to a maximum weight of 6000 lb, and unwinding, doubling and rewinding equipments are integral to the mill.

Wire, Strip and Bar

When Arthur Lee returned to England in 1870 after serving on the Northern side in the American Civil War, he married and settled in Sheffield, setting himself up in business as an iron and steel merchant. That was the beginning of Arthur Lee & Son Limited, which though now a public company, is still largely a family business, there being five members of the Lee family on the present board of directors. The history of the company as set out in a handsome illustrated brochure is something of a Yorkshire saga. They soon entered the wire business and went on to add bar and strip rolling. The range of products today encompasses hot and cold rolled steel strip, bright steel bars, high grade steel wire, all in a range of qualities and including the company's "Trubrite" stainless steel.

Wylfa

The Wylfa nuclear power station now under construction on Anglesey is to be increased in capacity to about 1,000,000 kW, thus making it the most powerful under construction anywhere in the world. The original scheme was for a capacity not exceeding 800,000 kW, based on a proposal to use pre-stressed concrete pressure vessels instead of steel vessels, thereby enabling a capacity of 400,000 kW to be obtained from each of two reactors. Further design work for the reactor units has indicated the feasibility of achieving a capacity of 500,000 kW for each.

Tension Distribution in a Belt Drive

Some Experiments

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Introduction

WHEN a light flat belt slips bodily over the periphery of a pulley, and the coefficient of friction is assumed constant over the whole of the contact surface, the following well-known relation holds:

$T_1/T_2 = e^{\mu\theta}$ where T_1 = tight side tension,
T_2 = slack side tension,
θ = angle of lap,
μ = coefficient of friction.

In a belt drive operating normally, however, the belt does not slip bodily over the pulley, yet it is clear that some slip must occur somewhere since the belt must extend while passing from slack side to tight side and contract while passing from tight side to slack side. As the belt extends or contracts it must slip relative to the surface of the pulley; and if this slip does not take place over the whole contact surface, then it must take place over part of it.

An incidental effect of this slip is a loss of energy and, in consequence, the efficiency of a belt drive under load must always be less than 100%, even though, in practice, the losses from this cause are usually small.

Since there is some slip of the belt relative to each pulley (forward slip on the driven pulley and backward slip on the driving pulley), it follows that the velocities of the parts of the belt between the pulleys will be different, i.e. faster on the tight side and slower on the slack side. One would expect, therefore, that, for the driven pulley, the region of no slip, where the pulley periphery has the same velocity as the belt, will be near the slack (slower) side while for the driving pulley the corresponding region will be near the tight (faster) side. This would mean that

$\omega_1/\omega_2 < R_2/R_1$ where R_1 = radius of driven pulley,
R_2 = radius of driving pulley,
ω_1 = angular velocity of driven pulley,
ω_2 = angular velocity of driving pulley.

which tallies with the conclusion that the efficiency of the drive is less than 100%.

The contact surface of each pulley, then, is divided into two parts corresponding to slip and no-slip, the no-slip region extending forward from the point at which the ongoing belt first reaches the pulley. In the no-slip region the belt tension remains constant. The angle subtended at the centre of each pulley by the no-slip region is called the "idle" angle and that subtended by the region of slip is called the "active" angle. It is clear that the active angle α must be the same for both pulleys since $T_1/T_2 = e^{\mu\alpha}$ for each of them. If the total angle of lap is different for the two pulleys, the idle angle will clearly be different also. As the transmitted torque is increased, (i.e. as T_1/T_2 is increased), α will increase and hence the idle angle will decrease until eventually the idle angle on the smaller pulley becomes zero and the belt slips bodily over its periphery; i.e. the active angle is now equal to the total angle of lap on the smaller pulley.

The theory outlined above is now generally accepted, has been extended,[1] and has had good experimental backing. The classic experiments on this subject were made in 1928 by H. W. Swift. He used a motor-driven belt drive specially constructed for power recirculation and measured the difference in speed between driving and driven pulleys of equal diameter for different values of belt load. He used belts made of various materials and his paper[2] includes a review of earlier work in the field.

A more recent piece of experimental work is that by E. O. Schneidersmann,[3] at the Technische Hochschule in Hanover. He demonstrated the active and idle angles directly by using a belt with alternate black and white stripes painted on the side in contact with the pulley. The pulley contained a light source which illuminated the belt through a hole in the pulley. The light was reflected back on to a photo-electric cell also contained in the pulley. The slip of the belt relative to the pulley therefore caused alternations in the output from the cell corresponding to successive black and white portions. By displaying this output on an oscillograph the active and idle angles could be clearly distinguished and measured.

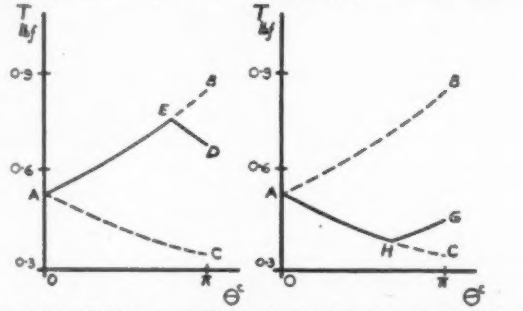

Fig. 1a (left) and 1b (right) respectively, tensions in latex strip belt under initial and intermediate conditions of loading

The apparatus used in all these experiments, though highly ingenious, was rather complicated. The work described below constitutes an attempt at investigating the tension distribution in a belt by very simple means, involving only static strain readings.

Experimental work

For the initial experiments, the "belt" used consisted of a strip of latex rubber, about 2 in. wide by 0·004 in. thick. This strip was placed over a fixed cast iron pulley about 14 in. dia and carried weight hangers at its free ends. The total angle of lap was thus fixed at 180°. The surface of the belt not in contact with the pulley carried ink lines perpendicular to its length which had been drawn 1 in. apart when the belt was unloaded. The ends of the belt were then loaded unequally in such a way as just to cause the whole belt to slip very slowly over the pulley. A very small weight was then added to the slack side load so that the belt just stopped slipping. The distances between successive ink lines were then measured with a flexible steel rule and the positions of the centres of the 1 in. segments were marked in pencil

on the surface of the pulley by the side of the belt. The end loads (including the hangers) were noted. The strip was now removed from the pulley, suspended vertically and loaded at its lower end with a series of ascending, and then descending loads. The extensions of one of the 1 in. segments was noted for each load and a load-deflection graph plotted.

From the limiting load ratio which had caused the belt to slip over the pulley, μ was calculated by using the expression $T_1/T_2 = e^{\mu\pi}$. The distances of the 1 in. segment centres from the initial point of contact of the ongoing belt were converted into angles, using the known radius of the pulley. The tension in each of the segments during slip was read off the load-deflection graph. Hence two graphs, one theoretical and one experimental, of tension against angular position were plotted between the same axes. There was reasonably good agreement between the two curves.

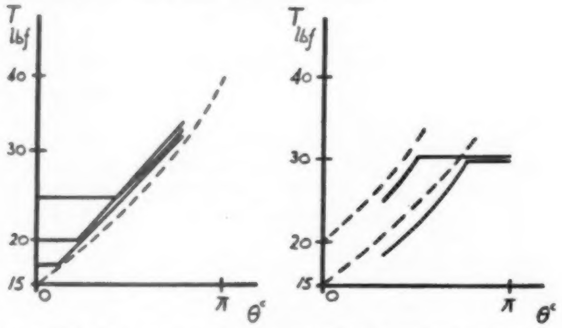

Fig. 2a (left) and 2b (right)—tensions in metal strip belt gauged from (a) slack side, and (b) tight side

The experimental work was now somewhat extended. The belt was placed over the pulley and again loaded until there was slip at all points of contact. The tight side load was then reduced in stages until eventually the belt began to slip bodily over the pulley in a direction opposite to that in which it had started. After every reduction in load each 1 in. segment was measured. The corresponding tensions, determined as before, were plotted against angular position and compared with the calculated values. There was again quite good agreement, the shape of the curves obtained being shown in Fig. 1a.

Here AB represents the initial loading with the whole belt just slipping over the pulley, i.e. $T_B/T_A = e^{\mu\pi}$. AED represents a typical intermediate loading where the original tight side load B has been reduced to D and $T_E/T_D = e^{\mu(\pi-\theta_E)}$. Eventually, the loading reaches the stage shown by AC when the whole belt just slips over the pulley in a direction opposite to that corresponding to AB, i.e. $T_A/T_C = e^{\mu\pi}$.

The loading was now restored, in stages, to the initial values and the tensions at every stage plotted as before and compared with the theoretical values. There was again quite good agreement. Fig. 1b. shows a typical intermediate loading AHG where $T_G/T_H = e^{\mu(\pi-\theta_H)}$. When the loading was complete, curve AB was again reached and the belt again just slipped bodily over the pulley in the initial direction.

It was now decided to try to make the experimental method more versatile by using, instead of the latex strip, a metal strip fitted with resistance strain gauges. The original idea was to use the same pulley as before and to use as many strain gauges as there had been 1 in. segments on the rubber strip. It soon turned out, however, that the bending strain caused by the small pulley was excessive and so a much larger pulley, of about 3 ft dia, was substituted. Also, it was found that one strain gauge was sufficient provided that the pulley was allowed to rotate so that the belt wound on and off it. This meant that only one gauge had to be calibrated and read and considerably simplified the procedure. Saunders-Roe foil strain gauges were used for active gauge and dummy. It was also found advisable to use as narrow a metal strip as possible so as to reduce the transverse twisting effect due to any lack of straightness of the strip. Beryllium copper was chosen as the material because of its negligible hysteresis, $\frac{1}{2}$ in. by 0·005 in. being the section used.

The strip was again calibrated by suspending it vertically and applying different loads to the weight hanger at its lower end. The angles of rotation of the pulley were measured by dividing the circumference into 15° segments marked on the pulley and aligning these marks with a fixed pointer.

As before, a uniform coefficient of friction was assumed and this coefficient was measured by using the same procedure as was used for the rubber strip. During this part of the procedure the pulley was prevented from rotating by being keyed to its shaft.

The slack side load was then increased, the key removed and the pulley rotated until the gauge was just on the pulley, at the slack side. At this point the tension in the belt was equal to the slack side load and the gauge was zeroed in this position. The pulley was then rotated 15° at a time and a reading of the strain gauge bridge taken after every rotation. Using the calibration curve previously obtained these readings were then converted into tensions and plotted against angular position. The whole experiment was carried out for several different values of slack side load, the tight side load being kept constant. The resulting graphs are shown in Fig. 2a, together with the calculated $e^{\mu\theta}$ curve, corresponding to the value of μ previously determined. The idle angles near the ongoing side of the belt are clearly shown. The experiment was now repeated with the gauge starting from the tight side and moving towards the slack side. The resulting graphs are shown in Fig. 2b, together with the relevant calculated curves. Again, the idle angles at the ongoing side are clearly shown. The total angle of rotation of the pulley in these experiments was somewhat less than 180°. The calculated curves in Figs. 2a and 2b are shown dotted.

During the experiments leading up to Fig. 2a, the constant tight side load was 40 lbf. The corresponding value for Fig. 2b was 30 lbf.

Conclusions and comments

Although the apparatus used in these experiments was extremely simple, it is clear that a good deal of information can be obtained in this way. The strain gauge method is not, of course, restricted to metal strips, nor to the relatively low loads used here. Most of the sources of inaccuracy were those common to all experiments in the field of dry friction, notably the impossibility of keeping constant the condition of the contact surfaces; all values of μ are therefore only approximate, quite apart from any assumptions made in the theory.

In the results shown, the worst discrepancy between experimental and calculated values is about 12%, though for most of the work described the accuracy was better than this.

Acknowledgment

The authors wish to express their gratitude to Mr. S. R. House, B.Sc.(Eng.), A.M.I.Mech.E., who by his unstinted help, advice and encouragement contributed so greatly to this work.

References

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[2] Swift, H. W., Power Transmission by Belts: an investigation of fundamentals. *Proc.I.Mech.E.*, Nov. 1928.
[3] Schneidersmann, E. O. Experiments with two-pulley belt drives, *Demag News* No. 126/1951.

The Molecular Sieve

Molecular sieves—or inert crystalline materials of controlled pore size of molecular dimensions—are finding increasing industrial and processing applications. Notable are the use of molecular sieve powders to remove water or similar contaminants from fluids, and their employment as 'carriers' in the formulation of one-part resin mixes to hold one of the active constituents inert during storage. The basic action and applications of molecular sieves are described

A MOLECULAR sieve consists, basically, of a regular network of cavities interconnected by channels of molecular dimensions. This form of structure is peculiar to certain types of crystals on dehydration, yielding unique adsorption properties. These can be put to advantage for drying, purification and similar processing requirements. Further extension of this basic property, however, enables molecular sieves to be employed as 'scavengers' to remove and retain undesirable contaminants in a fluid; or even to retain and isolate normally reactive components of a mixture (such as in two-part resin mix).

Commercial molecular sieve powders are produced from the class of minerals known as zeolites, chiefly embracing the alumino-silicates. In dehydrated powder form they are particles of two to three microns in diameter with a strong adsorption affinity for water and chemical solutions. The particles are themselves chemically inert and attacked only by such substances as strong acids. Liquid affinity is, therefore, a purely mechanical action and the extremely high internal surface area resulting from molecular-dimension porosity gives both high adsorption and high retention characteristics towards any fluid adsorbed.

Used as a water-adsorption agent, molecular sieve powders are essentially dessicants, but because of their complete inertness and unique adsorption and retention properties (even at elevated temperatures) they are generally referred to as 'scavengers'. At normal ambient temperatures the water capacity of a typical powder is of the order of 25 to 30% of its own weight. Such powders are finding increasing commercial application for the drying of gases and liquids of all types, and particularly the elimination of water from hydrocarbons, alcohols and similar fluids.

A particular use as a water scavenger is in the formulation of adhesives and synthetic resin coatings where water is an undesirable contaminant. This is particularly true in the vase of polyurethane finishes, for example, where water can cause 'gassing' and loss of properties. It is extremely difficult to exclude water from a typical coating formulation as it is a common contaminant with pigments and even the solvents used. The introduction of molecular sieve powders makes it possible to pre-dry pigments to any required level of water concentration, usually by grinding pigment and powder together in a mill.

A somewhat more spectacular application of molecular sieve powders is in improving the 'pot life' of two-part cold-setting resin mixes, typical of the modern range of adhesives. The mixing of the separate constituents (resin and catalyst) normally initiates an immediate reaction and subsequent gelling within a relatively short period of time, depending primarily on the ambient temperature.

By using molecular sieve powder as a 'carrier', i.e. loaded with one of the normally active constituents, it is possible to formulate a one-part mix with the 'active' ingredient held in latent form. Pot life may then be extended considerably, and in many cases almost indefinitely. Hence although supplied as a mix of the two (normally) reactive constituents, the formulation has a long shelf life.

The method of reactivating the inert constituent carried by the molecular sieve powder varies. With polyurethane and polyester formulations atmospheric moisture may provide the necessary reactivation. In other words, whilst the can is sealed the constituents remain inert, but when spread out in the form of a thin film (as in a paint coating), exposure to atmospheric moisture displaces the hitherto inert constituent from the molecular sieve carrier and allows normal reaction to proceed. Typically, a polyurethane 'one-part' mix rendered inert with a molecular sieve powder can exhibit normal cold-setting properties on exposure to air in a matter of two to three hours. In other cases it may be more expedient to effect displacement by heating or by solution treatment of the surface to be coated (e.g. coating with water which diffuses through the film and is evaporated off by the heat of exothermal reaction).

Basically, in fact, molecular sieve powders make possible normal 'one-pot' formulations of cold-setting

MECHANICAL PERFORMANCE OF TYPICAL MOLECULAR SIEVES*

	Related to Molecular Composition		
Pore Size	Smallest	Larger	Large
Molecules Passed and Absorbed	Small Molecules	Straight Chain Hydrocarbons and Similar Molecules	Branched Chain or Closed Chain Molecules
Molecules Stopped and not Absorbed	All Larger Molecules	Branched Chain or Closed Chain Molecules	—
Typical Fluids Absorbed	(i) Ammonia Fthanol Methanol Water Hydrogen Sulphide Sulphur Dioxide	(ii) All in Column (i) plus Butane n-Butanol n-Alcohols Cyclopropane n-Olefins	(iii) All in Columns (i) and (ii) plus Isobutane Isopropanol Benzene Aromatic Hydrocarbon Cyclohexane Carbon Tetrachloride

*Linde Company (Division of Union Carbide Corporation)

This table shows how the size of the molecular sieve channels affects the adsorption characteristics. Used as a 'scavenging' agent it is, therefore, necessary to select a suitable grade of powder. Thus a powder with the smallest pore size would effectively act as a scavenger for water in alcohols, benzene, etc. (i.e. all fluids listed in columns (ii) and (iii). A powder with large pore size, however, would be capable of adsorbing both water and alcohol, benzene, etc., and thus would not act as an effective scavenging agent in this case.

synthetic resin finishes and adhesives which it has normally only been possible to produce as two-part formulations to be mixed immediately before use and possessing a strictly limited pot life. How far this particular application will be carried in the field of coatings and adhesives remains to be seen.

A further useful application of molecular sieve powders is as 'degassing' agents in the formulation of metal pigmented paints, notably paints with high zinc content. It is a typical characteristic of such paints that any water contaminant will cause appreciable gassing, leading to the evolution of hydrogen and a build up of pressure inside the can, with the metallic particles becoming oxidized. The necessary water contamination to promote this reaction is normally introduced via the ingredients. The ingredients can be pre-dried with molecular sieve powders, and an additional small proportion of powder added, if necessary, to take care of any subsequent contamination.

Red Silicone Insulating Compound

Ambersil M.S. 4. silicone insulating compound containing a red dye is now available as an alternative to the colourless Ambersil M.S. 4., manufactured by Amber Oils Limited, 11a Albemarle Street, London W1. The properties and price are identical but the presence of the dye shows up exactly which areas have been treated and so leads to more economical application. The new red has been introduced particularly to meet the requirements of large users and of those working on Ministry contracts. It should also help service mechanics and electricians treating areas which, although within range of the spray jet, cannot be readily visually examined in the absence of a contrasting colour. Red Ambersil M.S. 4. is distinguished from the white compound by the provision of a red cap to the aerosol, and a yellow button, which will stain red after initial usage. Both the original colourless and the new Red compound are now available in half-gallon, one gallon and five gallon containers.

Electrical Sleeves and Tapes

Two additions to their range of materials, are announced by Tygadure Limited, Littleborough. The first is a range of 'Tygaflor' extruded ptfe electrical sleeving available in sixteen sizes ranging in internal diameter from 0·015 in. to 0·108 in. and in eleven standard colours and natural, and having a dielectric constant of 2·6, a power factor of less than 0·002 over a wide frequency range, a volume resistivity of 10^{15} ohms/cm^3, and temperature range $-100°$ C to $+250°$ C. It is also chemically inert and fungus proof. The sleevings are also available with a cementable outer surface enabling them to be used in potted circuits, etc.

The second new product is a range of 'Tygaflor' lacing cords and tapes for securing electrical wiring harnesses where temperature extremes (+250 and $-100°$ C), and chemical and biological attack are experienced. They combine the intrinsic attributes of ptfe and glass fibre, being braided glass fibre yarns pre-coated with a smooth even ptfe film. The double layer of ptfe separating each yarn prevents abrasion. High knot strength, long flex life and flexibility are thus assured. The range varies from cords 0·037 in. dia with a breaking strain of 40 lb, to a 0.120 in. wide tape, breaking strain 100 lb.

Preliminary Design of Gas Turbine Plant—X

Compressor-turbine calculations

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10.1. Cycle calculation results

The following results are taken from the Cycle Calculations of Sect. 6, notably the table of results of Sect. 6.2.3. Throughout the turbine calculations the Section number will be followed in parenthesis by the relevant Section number of the turbine treatment of Sect. 9.

(9.7) $P_{in} = 65{\cdot}16$, $T_{in} = 1000$, $P_{out} = 28{\cdot}10$, $T_{out} = 829$, $\delta T = 171$, $Q = 45{\cdot}0$, $\delta H = 46{\cdot}50$, $k = 0{\cdot}2724$, $\gamma = 0{\cdot}2724/(0{\cdot}2724-0{\cdot}0686) = 1{\cdot}34$, $\gamma/\eta_{\infty}(\gamma-1) = 4{\cdot}465$, $q = 0{\cdot}00901$.

10.2 (9.8)

This was calculated in Sect. 8.3 for the compressor but is repeated here.

$M_{out} = 0{\cdot}3$, $\delta\gamma = -0{\cdot}01$, $V_a/\sqrt{T} = 19{\cdot}23 - 13{\cdot}3 \times 0{\cdot}3 \times 1{\cdot}7 \times 0{\cdot}01 = 19{\cdot}16$, $V_a = 19{\cdot}16\sqrt{829} = 551$, $Q\sqrt{T}/AP = 0{\cdot}1915 - 0{\cdot}18 \times 0{\cdot}3 \times 0{\cdot}01 = 0{\cdot}1910$, $A_{out} = (45{\cdot}0\sqrt{829})/(0{\cdot}191 \times 28{\cdot}1) = 241{\cdot}4$, $\frac{1}{4}\pi d_o^2 = 241{\cdot}4/0{\cdot}64 = 377$, $d_o = 21{\cdot}92$ $d_i = 0{\cdot}6 \times 21{\cdot}92 = 13{\cdot}15$, $N = 137600/13{\cdot}15 = 10{,}460$ for $u_i = 600$, $\frac{1}{4}\pi d_i^2 = 136$.

(9.9) But compressor must run at 7600 as established in Sect. 8.2, hence, without gearing, i.e. if direct-coupled, the turbine must run at 7600. Hence $d_i = 600 \times 7600/10{,}460 = 436$.

10.3 (9.10)

$$k\Delta T_{2max} = (436/161)^2 + 4{\cdot}36 \times 5{\cdot}51/12{\cdot}92 = 7{\cdot}33 + 1{\cdot}86 = 9{\cdot}19$$

(9.11) $k\Delta T_{1max} = 1{\cdot}1 \times 9{\cdot}19 = 10{\cdot}11$

10.4 (9.12)

$(k\delta T - k\Delta T_{2max})/k\Delta T_{1max} = (46{\cdot}50 - 9{\cdot}19)/10{\cdot}11 = 37{\cdot}31/10{\cdot}11 < 4$

$$\therefore n = 5 \text{ and } k\Delta T_2 = (46{\cdot}50 \times 9{\cdot}19)/(9{\cdot}19 + 4 \times 10{\cdot}11) = 8{\cdot}60$$

$$\therefore k\Delta T_1 = (46{\cdot}50 - 8{\cdot}60)/4 = 9{\cdot}48.$$

10.5 (9.13.1)

$M_{a\,in} = 0{\cdot}3$, $Q\sqrt{T}/AP = 0{\cdot}1910$

$A = 45{\cdot}0\sqrt{1000}/(0{\cdot}191 \times 65{\cdot}16) = 114{\cdot}3$

$\therefore \frac{1}{4}\pi d_o^2 = 138$ (from Sect. 10.2) $+ 114{\cdot}3 = 252{\cdot}3$

$\therefore d_o = 17{\cdot}93$

(9.13.2) $T_{out} = 1000 - 9{\cdot}48/{\cdot}2724 = 1000 - 34{\cdot}8 = 965{\cdot}2$

$P_{out} = 65{\cdot}16\,(965{\cdot}2/1000)^{4{\cdot}465} = 65{\cdot}16 \times 0{\cdot}8535 = 55{\cdot}6$

$M_{a\,out} = 0{\cdot}3$.

$Q\sqrt{T}/AP = 0{\cdot}1910 \therefore A = 45{\cdot}00\sqrt{965{\cdot}2}/(0{\cdot}1910 \times 55{\cdot}6) = 131{\cdot}7$

$\therefore \frac{1}{4}\pi d_o^2 = 138 + 131{\cdot}7 = 269{\cdot}7 \therefore d_o = 18{\cdot}53$

$(V_a/\sqrt{T})_{out} = 19{\cdot}16 \therefore V_a = 19{\cdot}16\sqrt{965{\cdot}2} = 592$

	First Stage	Last Stage
10.6 (9.14)	$d_{m\ out} = \frac{1}{2}(13\cdot15 + 18\cdot53)$ $= 15\cdot84$ $u_{m\ out} = 436 \times 15\cdot84/13\cdot15$ $= 525$ $d_{or} = 0\cdot995 \times 18\cdot53 = 18\cdot44$ $d_{mr} = 0\cdot995 \times 15\cdot84 = 15\cdot76$ $u_{mr} = 0\cdot995 \times 525 = 522$ $h_r = 15\cdot76 - 13\cdot15 = 2\cdot61$	$d_{m\ out} = \frac{1}{2}(13\cdot15 + 21\cdot92)$ $= 17\cdot53$ $u_{m\ out} = 436 \times 4/3$ $= 581$ $d_{or} = 0\cdot995 \times 21\cdot92 = 21\cdot81$ $d_{mr} = 0\cdot995 \times 17\cdot53 = 17\cdot44$ $u_{mr} = 0\cdot995 \times 581 = 578$ $h_r = 17\cdot44 - 13\cdot15 = 4\cdot29$
10.7 (9.15)	$\tan \alpha_{3i} = \frac{45{,}080 \times 9\cdot48 - 0\cdot98 \times 525^2}{1\cdot98 \times 436 \times 592}$ $= \frac{427{,}500 - 270{,}000}{511{,}500}$ $= \frac{157{,}500}{511{,}500} = 0\cdot306$ $\tan \alpha_{0i} = \frac{427{,}500 - 436 \times 592 \times 0\cdot306}{255{,}750}$ $= \frac{427{,}500 - 79{,}000}{255{,}750}$ $= \frac{348{,}500}{255{,}750} = 1\cdot363$ $\tan \alpha_{1i} = 1\cdot363 - \frac{436}{0\cdot99 \times 592}$ $= 1\cdot363 - 0\cdot743 = 0\cdot620$ $\tan \alpha_{2i} = 0\cdot306 + 436/592$ $= 0\cdot306 + 0\cdot736 = 1\cdot042$ $\alpha_1 = 31\cdot8,\ \alpha_2 = 46\cdot2,\ (\alpha_3 = 17\cdot0)$	$\tan \alpha_{3i} = \frac{45{,}080 \times 8\cdot60 - 0\cdot98 \times 581^2}{1\cdot98 \times 436 \times 551}$ $= \frac{388{,}000 - 331{,}000}{476{,}500}$ $= \frac{57{,}000}{476{,}500} = 0\cdot1196$ $\tan \alpha_{0i} = \frac{388{,}000 - 436 \times 551 \times 0\cdot1196}{238{,}250}$ $= \frac{388{,}000 - 28{,}750}{238{,}250}$ $= \frac{359{,}250}{238{,}250} = 1\cdot506$ $\tan \alpha_{1i} = 1\cdot506 - \frac{436}{0\cdot99 \times 551}$ $= 1\cdot506 - 0\cdot798 = 0\cdot708$ $\tan \alpha_{2i} = 0\cdot1196 + 436/551$ $= 0\cdot1196 + 0\cdot791 = 0\cdot911$ $\alpha_1 = 35\cdot3,\ \alpha_2 = 42\cdot3,\ (\alpha_3 = 6\cdot8)$
10.8 (9.16)	$i = o,\ \beta_1 = \alpha_1 = 31\cdot8$ $\beta_2 = 10 + 0\cdot867 \times 46\cdot2 = 50\cdot1$ $\theta = 31\cdot8 + 50\cdot1 = 81\cdot9$	$i = o,\ \beta_1 = \alpha_1 = 35\cdot3$ $\beta_2 = 10 + 0\cdot867 \times 42\cdot3 = 46\cdot7$ $\theta = 35\cdot3 + 46\cdot7 = 82\cdot0$
10.9 (9.17)	$d_i/d_{or} = 13\cdot15/18\cdot44 = 0\cdot713$ (uncooled blades) $(s/c)_i = 0\cdot56$ $(t/c)_i = 0\cdot173$ $(t_o/t_i)_u = 0\cdot42$	$d_i/d_{or} = 13\cdot15/21\cdot81 = 0\cdot603$ (uncooled blades) $(s/c)_i = 0\cdot49$ $(t/c)_i = 0\cdot15$ $(t_o/t_i)_u = 0\cdot35$
10.10 (9.18.1)	$V_{a\ in} = 0\cdot99 \times 592 = 586$ $\delta T_{va} = \frac{586^2}{90{,}160 \times 0\cdot2724} = 14\cdot0$ $T_b = 1000 - 14(1\cdot363^2 - 0\cdot87 \times 0\cdot62^2)$ $= 1000 - 14\,(1\cdot86 - 0\cdot33)$ $= 1000 - 21\cdot4 = 979$	$V_{a\ in} = 0\cdot99 \times 551 = 545$ $\delta T_{va} = \frac{545^2}{90{,}160 \times 0\cdot2724} = 12\cdot0$ $\Delta T_2 = 8\cdot60/0\cdot2724 = 31\cdot5$ $T_b = (829 + 31\cdot5) - 12(1\cdot506^2 - 0\cdot87 \times 0\cdot708^2)$ $= 860\cdot5 - 12(2\cdot27 - 0\cdot44)$ $= 860\cdot5 - 20\cdot8 = 840$
10.11 (9.19) **(Using Calculation)**	$t = 50{,}000$ hr, Nimonic 90. $\frac{1450 - T_b}{t^{0\cdot0445}} = \frac{471}{1\cdot619} = 291$ For F_s, $m = 2\cdot266$, $n = 5\cdot85$ $F_s = \left(\frac{291}{184}\right)^{5\cdot85} = 1\cdot582^{5\cdot85} = 14\cdot6$ For F_f, $m = 2\cdot13$, $n = 3\cdot583$ $F_f = \left(\frac{291}{135}\right)^{3\cdot583} = 2\cdot16^{3\cdot583} = 15\cdot7$	$t = 50{,}000$ hr, Nimonic 90. $\frac{1450 - T_b}{t^{0\cdot0445}} = \frac{610}{1\cdot619} = 377$ For F_s, $m = 1\cdot865$, $n = 1\cdot99$ $F_s = \left(\frac{377}{73\cdot5}\right)^{1\cdot99} = 5\cdot13^{1\cdot99} = 25\cdot9$ For F_f, $m = 1\cdot168$, $n = 0\cdot934$ $F_f = \left(\frac{377}{14\cdot75}\right)^{0\cdot934} = 25\cdot6^{0\cdot934} = 20\cdot7$

First Stage	Last Stage
10.12 (9.21.1) **Straight taper** $t_o/t_i = 0{\cdot}42,\ d_i/d_o = 0{\cdot}713$ $\phi = 1 - \frac{0{\cdot}58}{3} \times \frac{2{\cdot}713}{1{\cdot}713} = 1 - 0{\cdot}306$ $= 0{\cdot}694$	**Straight taper** $t_o/t_i = 0{\cdot}35,\ d_i/d_o = 0{\cdot}603$ $\phi = 0{\cdot}648$ (for limiting case)
10.13 (9.22) $f_c = 0{\cdot}990 \times 0{\cdot}694 \times \frac{2{\cdot}61}{15{\cdot}76} \times 5{\cdot}22^2 = 3{\cdot}13$	$f_c = 0{\cdot}990 \times 0{\cdot}648 \times \frac{4{\cdot}29}{17{\cdot}44} \times 5{\cdot}78^2 = 5{\cdot}27$
10.14 (9.23) Assume $n = 5$ $(F_f/n)^2 = (15{\cdot}7/5)^2 = 9{\cdot}86$ $\frac{4F_s(F_s - f_c)}{(F_f/n)^2} = \frac{4 \times 14{\cdot}6 \times 11{\cdot}47}{9{\cdot}86} = 67{\cdot}9$ $f_b = \frac{9{\cdot}86}{2 \times 14{\cdot}6}(\sqrt{68{\cdot}9} - 1) = 2{\cdot}465$	Assume $n = 5$ $(F_f/n)^2 = (20{\cdot}7/5)^2 = 17{\cdot}2$ $\frac{4F_s(F_s - f_c)}{(F_f/n)^2} = \frac{4 \times 25{\cdot}9 \times 20{\cdot}63}{17{\cdot}2} = 124{\cdot}2$ $f_b = \frac{17{\cdot}2}{2 \times 25{\cdot}9}(\sqrt{125{\cdot}2} - 1) = 3{\cdot}38$
10.15 (9.25) $b = 1420 - 9{\cdot}3 \times 81{\cdot}9 = 659$ $a = \frac{272 - 81{\cdot}9}{148} = 1{\cdot}285$ (9.26) $\tan \zeta = \frac{1}{2}(\tan 50{\cdot}1 - \tan 31{\cdot}8)$ $= \frac{1}{2}(1{\cdot}195 - 0{\cdot}620) = 0{\cdot}288$ $1 + \tan^2 \zeta = 1{\cdot}083,\ \zeta = 16{\cdot}1$ (9·27) $c^2 = \frac{659 \times 1{\cdot}083 \times 45{\cdot}00 \times 9{\cdot}48 \times 2{\cdot}61 \times 0{\cdot}56}{1{\cdot}73^{1{\cdot}285} \times 5220 \times 13{\cdot}15 \times 2{\cdot}465}$ $= 1{\cdot}292 \quad \therefore c = 1{\cdot}135$	$b = 1420 - 9{\cdot}3 \times 82 = 657$ $a = \frac{272 - 82}{148} = 1{\cdot}283$ $\tan \zeta = \frac{1}{2}(\tan 46{\cdot}7 - \tan 35{\cdot}3)$ $= \frac{1}{2}(1{\cdot}061 - 0{\cdot}709) = 0{\cdot}176$ $1 + \tan^2 \zeta = 1{\cdot}031 \qquad \zeta = 10{\cdot}0$ $c^2 = \frac{657 \times 1{\cdot}031 \times 45{\cdot}00 \times 8{\cdot}6 \times 4{\cdot}29 \times 0{\cdot}49}{1{\cdot}5^{1{\cdot}283} \times 5780 \times 13{\cdot}15 \times 3{\cdot}38}$ $= 1{\cdot}275 \quad \therefore c = 1{\cdot}130$
10.16 (9.28) $\omega = 1{\cdot}135 \cos 16{\cdot}1 = 1{\cdot}09$ $\omega_s = 2\frac{2}{3} \times 1{\cdot}09 = 2{\cdot}905$	$\omega = 1{\cdot}13 \cos 10 = 1{\cdot}112$ $\omega_s = 2\frac{2}{3} \times 1{\cdot}112 = 2{\cdot}965$

$$L = 5 \times \tfrac{1}{2}(2{\cdot}905 + 2{\cdot}965) = 14{\cdot}7 \text{ in.}$$

To be continued.

Centralized Temperature Indication

A single instrument with push-button selection for indicating temperature conditions at 24 remote points has been introduced by Smiths Industrial Division, Wembley, for compact design of control panels in boilerhouses, steelworks and chemical plants. The instrument measures output voltages of 1 millivolt fsd to a maximum, non-attenuated range of 100 millivolt fsd and is suitable for use with thermocouples, resistance thermometers, strain gauges, load cells and other industrial transducers. Where more than 24 points are required, remote switching units, capable of handling up to 60 points can be added. Slide wire resistors and slip rings are eliminated by the use of a null-balance detection system where the input is continually compared with a voltage developed across a fixed resistance. The error signal supplies a servo motor which drives a force balance unit to adjust the current through the resistance until the error signal is reduced to zero.

Flame-proof Motors

A new range of squirrel-cage motors with flame-proof enclosure is announced by Crompton Parkinson Limited, Aldwych, London, WC2. This is a further piece of standardization conforming to the requirements of B.S. 229 and 741 and certified for Gas Groups 1, II & III, by the Government Testing Station at Buxton. Complete interchangeability of fixing dimensions and centre height is possible whichever enclosure is necessary on the driven machine. Internal details of the machines are not affected and still conform strictly to B.S. 2613 for performance. The only limitation is that the designs are suitable for three phase supplies between 100 and 600 volts.

Flexible Grommet Material

New "Flexiform" grommets are produced in flexible, straight lengths to line and grip odd-shaped, undersized or oversized holes, eliminating the need for varied diameter grommets. Manufactured in either red, black, blue and natural Nylon, or in Teflon, the grommets are in strip form to be cut to required size, in standard lengths for Nylon, 12¾ in. for up to 4 in. hole, and Teflon 19 in. for up to 6 in. hole. Nylon is for applications up to 135° C and Teflon up to 260° C. Both range in sizes to fit material thicknesses of 0.015 in. up to 0·510 in. Makers are Hellermann Limited, Gatwick Road, Crawley, Sussex.

Metal Sawing

Sawing was once something in the nature of an art, but today it is becoming a science based on recognized principles and utilizing tools far more varied, complex and efficient than could have been dreamed of a hundred years ago. The saws dealt with here are primarily designed for cutting metal, either hot or cold, but the temperature of the work is important because it governs the form of saw

CIRCULAR hot saws are provided with teeth of two different forms. Most users prefer the first form shown in the accompanying sketch, others the slightly different alternative form also shown. The pitch of the teeth is mainly dependent on the diameter of the saw and the metal to be cut.

These saws run best at a speed of between about 12,000 and 18,000 ft per min, the exact speed being found by adjustment to suit the particular work.

Circular hot saws should not be used for cutting off feeding heads and runners that have cooled to a black-hot condition. If castings have cooled to this state and only saws of this type are available, it is advisable to reheat the castings. The saw must never be forced hard into the metal, but brought steadily into it. If the saw is roughly used it will crack or even buckle or distort. The work must be held tightly to prevent "play" in the cut.

In sawing hot metal there are constantly fluctuating temperatures in the cutting blade, which all too often cause cracks. Not only is the work hot, but the cutting itself generates heat. Each cut is made at a slightly different temperature from the previous one because of the alternate heating and cooling between cuts.

Cracks in the saw can be treated by drilling small holes at their ends to stop them from spreading, and then resharpening the teeth, but this is not recommended except in emergency. Cracks that run horizontally to the teeth are dangerous because they may cause a piece of the saw to fly off. It is always better to take a cracked saw out of commission and send it back to the maker to be cut down to a smaller diameter and given fresh teeth, if this is worth the cost.

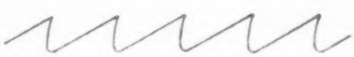
A common mistake is to use a saw with too large a pitch. Small runners and other sections can get locked in too large teeth and cause breakage. If a circular hot saw is carefully used it can be re-toothed, repaired and re-used a good many times.

The sawmaker may ask whether a hot saw is required in the black "as rolled" condition or with a ground finish. The advantage of the ground finish is that it produces a better balanced saw with greater cutting clearance, and therefore gives better working results, but it is more expensive. The material of which the saw blade is made largely governs the metals on which it can be used. For ferrous metals it is better to use a special alloy steel circular saw rather than one of plain carbon steel for cold cutting.

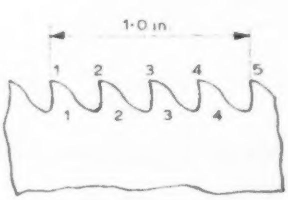
The operator of any type of saw must make sure that his machine is kept in good order and the saw correctly fitted before use. Feed and speed must be properly selected. Sharpening of the teeth is important: too many saws come back to their makers with blunted, broken and uneven teeth, showing that they have not been kept sharp or properly looked after.

Sharpening should be done with a free-cutting abrasive wheel, each tooth being sharpened in turn so that the entire saw is gone round two or three times. The wheel must not press too hard on the blade or this will "blue" the teeth and make them too soft for effective sawing. The original form of the teeth should be maintained as far as possible, and care must be taken not to cut sharp corners in the gullets as this will probably crack the saw, especially when the teeth become dull. The grinding wheel must also be kept to the proper form so that it does not produce faulty teeth. There must be plenty of backing left behind the teeth to give them support.

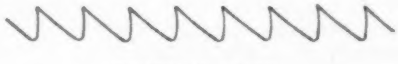
HOT SAW TOOTH



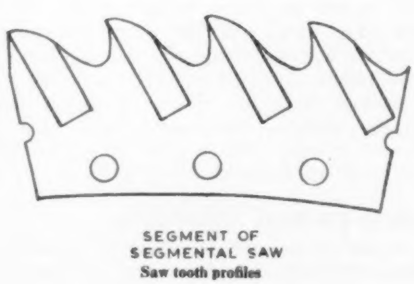
ALTERNATIVE FORM OF HOT SAW TOOTH



5 TEETH IN 1·0 in.
6 POINTS TO 1·0 in.



BANDSAW TEETH



SEGMENT OF SEGMENTAL SAW

Saw tooth profiles

The cutting of cold metal with a circular cold saw is often complicated by the wide variety of metals cut in the same shop and the occasional lack of experience of the saw operators. The most important developments up to fifteen years ago were the hydraulic sawing machine, the segmental saw and the tungsten carbide tipped saw; improvements in the form of the saw teeth and in the means of sharpening the saws; and improvements in the quality of steel used for the saw blades. Since that date there have been additional important advances.

Hydraulic sawing machines give more control and flexibility of operation. Variable speeds and feeds can be embodied for quick, cheap and accurate sawing of all qualities and sections of steel. On the other hand, the operator is all-important in this type of machine as there is no link between the rate of feed and the speed of saw. A careless operator may use the same feed at 70 fpm peripheral speed of the saw and 25 fpm peripheral speed. This is not possible with mechanical feed linked to the saw speed.

Circular solid cold saw blades are now made in two different qualities of steel: tungsten and chromium alloys. The saws are obtainable in various sizes and gauges and usually supplied with a bright finish. The form of tooth mostly used is of the hand-saw type with a radius at the bottom of the gullet to prevent cracks, but sometimes a gullet type of tooth is used. All depends on the metal to be cut. A different form of tooth is needed for thin sections from that for heavy solid sections, which need a larger tooth.

The same remarks regarding sharpening the teeth of hot saws apply to cold saws also. Their teeth should be freed from bits of metal that might lock and cause them to break off. For this purpose a wire brush is best.

In operation, the same precautions as for hot saws are essential, and if the blade chatters in the saw cut the saw should at once be taken out and resharpened or wear will be excessive and regrinding will be severe, which reduces the service life of the blade. The saw centres must be properly fitted on the arbour of the saw sharpening machine, and also on the flange of the sawing machine.

The circular cold sawing machine will work at a greater capacity and on a wider range of sizes, weights and shapes, than any other cutting method. The life of the blade is long, partly because the interrupted cut gives each tooth time to cool down a little as it revolves before coming down for the next cut. The sawing machines are, moreover, highly efficient because they are designed for one operation only.

Cold saws should pass freely through a lubricant. The ordinary mixture of soap and water gives good results. The bearings of the sawing machine and other working parts should be regularly overhauled because wear or looseness can break the saw. In general, the peripheral speed of the saw should increase as sectional dimension decreases. Feed should go up as Brinell hardness goes down. The teeth of the saw should be carefully maintained both as to form and to height, and the blade should be perfectly round. Cuttings coming away with a bright blue colour show that too much heat is being generated so that speed and feed should be reduced till this no longer happens.

The segmental metal-cutting saw blade has a body of hardened and tempered high tensile steel fitted around its rim with segments of super-high-speed-steel. The form and number of teeth to each segment are carefully chosen to suit the class of work. A number of teeth is contained in a single segment and the segments are secured to the saw body. Usually, any segment for a specified diameter of saw will fit in any position on any blade of identical diameter. When more than one segment has to be replaced, however, the body of the saw is usually in need of attention and should be sent back to the makers for re-smithing and truing up.

Segmental saws will stand up to the severest cutting and can take high rates of feed even in tough alloy steel. They cost more than a solid saw but not so much as to make their use uneconomical, and this higher first cost is soon repaid. The teeth should be as carefully looked after as the teeth of a milling cutter. There should always be a good radius at the root, while every alternate tooth should be bevelled off to break up the chips and stop them from choking the teeth. Sharpening must be regular and done carefully.

The teeth produce spiral chips, not pieces as do solid saws. In resharpening the proper form is ground on *all* teeth, taking off just enough to remove wear. This is known as re-gulleting. Then the roughing teeth are backed off, adjusting the feed pawl of the sharpening machine to engage alternate teeth and reducing the reciprocation of the grinding wheel head. The amount of rise and fall necessary on the head for this operation lies usually between $\frac{1}{8}$ and $\frac{1}{4}$ in. The finishing teeth are then backed off, grinding off 0·015 in. to leave the roughing teeth with the necessary projection. The 7° to 8° top rake must be carefully maintained. Finally the roughing teeth are bevelled to an included angle of 80°, leaving the land in the middle equal to one third of the saw width.

The cutting clearances must suit the metal to be cut. The grinding wheel must fit well on the spindle, and its sides be kept straight or the proper cutting angle will not be obtained. If a new or re-sharpened saw is put into service, the speed and the feed should both be low for the first few cuts, after which the saw can be brought gradually up to normal speed.

For insertion of a new segment, punch or drill out the rivets that hold the old segment in place and remove the segment. On inserting the new segment, make sure that it fits closely against its adjacent members and to the shoulder of the saw body. A new segment is always from 0·005 to 0·008 in. longer than is required, to provide for grinding so that the segment will fit accurately. The rivets must fit the holes closely and a small amount of "draw" is provided to ensure that riveting pulls the segment down on the shoulder of the body. The new segment may then be riveted into place and the surplus metal removed from the rivet heads. The new segment must not have teeth standing out "proud" above the other segments and therefore they must be ground to the same height before use. If a full set of new segments is required, the saw body should be sent to the makers for fitting and reconditioning.

In using segmental saws see that the work is firmly held in the machine and the saw itself not nipped by overhanging ends. When cutting sections at an angle, feed the saw gradually into the work by hand until the automatic feed can be safely engaged. Copious lubrication at the point of contact of saw and work is essential. A chip-remover should be used to clear chips from the teeth.

To be continued.

VOLTAGE CONTROL

Saturable Reactors

Volt drop on consumer's cables—a stabilizing transformer unit—a stabilized variable-voltage unit—use of a reference voltage—a stabilizer with undistorted output—a booster transformer stabilizer

By J. L. WATTS, A.M.I.E.E.

THE supply voltage at the terminals of a consumer fed from the electricity supply main may, under normal conditions, vary as much as $\pm$ 6% added to which there may be an appreciable volt drop on the cables from the consumer's terminals to certain items of plant.

The I.E.E. Regulations require that the size of every cable shall be such that the volt drop from the consumer's terminals to any point on the installation shall not exceed 1 volt plus 2% of the normal voltage when the cables are carrying the maximum r.m.s. current under normal conditions of service; except for motor circuits, where the volt drop should not exceed $7\frac{1}{2}$% of normal voltage on full load; or where the voltage at the consumer's terminals is so regulated as to be approximately constant irrespective of variations of supply voltage, when the volt drop shall not exceed 5% of normal voltage.

To minimize volt drop, which varies with the load current, the cables should be of adequate size. The normal current rating of a cable is determined by heating considerations but, on a long cable run, volt drop considerations may call for cables of greater current rating than the full-load current. In most cases lower volt drops than are permitted by the I.E.E. Regulations are desirable. In any case normal variations of supply voltage may be too great for correct operation of some types of equipment, such as chemical processing, photometry, heating purposes, automatic control, furnace controls etc. For other purposes a voltage which is higher or lower than the supply voltage may be needed.

There are, however, many devices which can be used to stabilize the voltage applied to consuming apparatus. One such system employs two transformers connected as in Fig. 1. Transformer B is designed so that its core operates with a high magnetic flux density and becomes saturated with magnetism during the peak periods in each half cycle of the a.c. supply. The induced voltage in the windings is proportional to the rate of change of the magnetic flux, and the constant flux during the saturation periods thus limits the voltage across the primary windings P_1 and the voltage V_1 across the secondary windings S_1. Thus if the supply voltage increases, say, most of the increased voltage will be applied to the primary windings P_2 of the unsaturated transformer A, so that the core flux and the voltage V_2 induced in its secondary winding S_2 will increase to a greater degree than the supply voltage. Connexions are such that V_2 is in opposition to V_1 to give an output voltage which is more or less constant irrespective of normal changes of supply voltage.

Fig. 2. shows the basic connexions of a somewhat similar arrangement which can be used as an automatic voltage regulator giving up to about 6 kVA of controlled voltage at 85% to 115% of the supply voltage. On a given setting the output voltage is maintained within $\pm$ 1·5% for wide changes of line voltage or load. For maximum output voltage the maximum positive value of control current is passed through the control winding C_1 of the reactor A to saturate the core, so that its load windings L_1 then have a low impedance. The control current through the control windings C_2 of the reactor B then has a magnetic effect in opposition to the bias current through the windings b_2, so that the core of B is unsaturated and the load windings L_2 have a high impedance. Under these conditions the load is virtually connected between the points D and F and maximum voltage is applied to the load.

On the other hand, when the control current is set to its maximum negative value the reactor B becomes saturated whilst A remains unsaturated. The load is then effectively connected between D and E so that minimum voltage is applied. Variation of load current through the load windings of the reactors on varying loads affects the degree of saturation of the cores in such a way as to give almost a constant output voltage on a given bias and control current.

Fig. 3 gives the connexions of a small stabilizer suitable for maintaining the voltage applied to the heating filaments of valves used in precision electronic equipment within $\pm$ 1% under conditions of varying supply voltage and frequency. The primary windings of the heater transformer are fed through the load

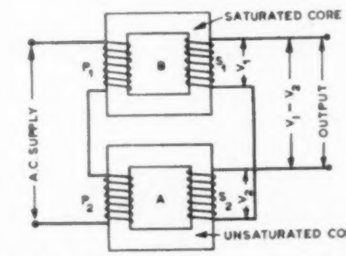


Fig. 1.—Arrangement of saturable transformers for constant output voltage

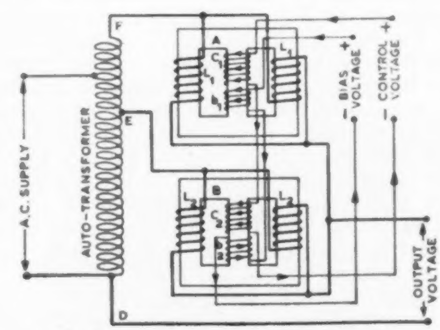


Fig. 2.—Connexions of a line voltage regulator

windings L of a saturable reactor, a constant current being passed through the control windings C from a stablized voltage source, such as a stabilized H.T. supply.

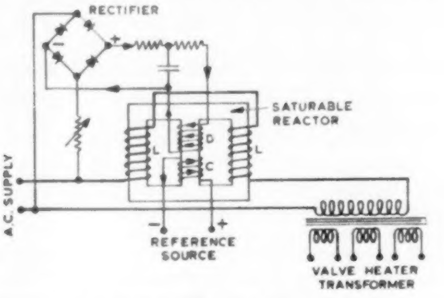


Fig. 3.—A stabilizer circuit for valve heaters

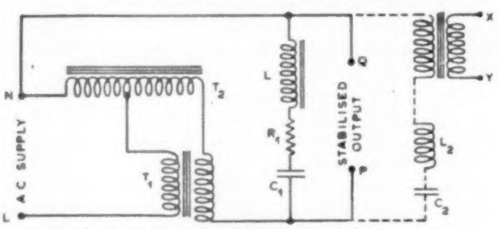


Fig. 4.—Basic circuit for stabilizer with undistorted output

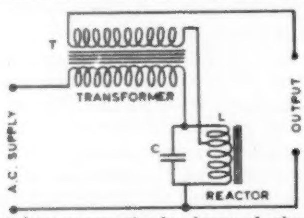


Fig. 5.—Voltage regulator compensating for changes of voltage and load current

A second control winding D, in magnetic opposition to C, is energized through a metal rectifier fed from the a.c. supply. In the event of fall of the supply voltage, say, the reduced current through D will result in an increase of the resultant amp-turns of C and D, thus increasing the core saturation and reducing the impedance of the load windings L, so as to increase the proportion of the supply voltage applied to the primary windings of the heater transformer.

For some purposes it is a disadvantage that saturable reactors normally tend to introduce harmonics into the output voltage. However, Fig. 4 shows the basic circuit of a voltage stabilizer designed to provide an almost undistorted voltage output within plus or minus 2% of the supply voltage, with unity power factor at all loads between no load and full load, if the supply voltage varies between 83% and 113% of normal at normal frequency. For this purpose the load may be connected between terminals P and Q. The stabilizer includes an auto-transformer T_2 with a double-wound transformer T_1, and a filter circuit comprising the reactor L and capacitor C_1.

At 50 cycles the filter circuit L and C_1 passes a current which leads the voltage. However, third harmonics at 150 cycles are induced in the magnetic circuit of the saturable core of T_2, and at this frequency the filter circuit becomes resonant. The energy stored in the capacitor C_1 during parts of each cycle is then converted into electromagnetic energy in L during other parts of each cycle. At 150 cycles the impedance of the filter circuit is thus mainly due to its resistance, and the 150 cycle harmonic currents are dissipated in the resistance instead of being passed into the load circuit. Such stablizers are available with outputs of 30 to 1200 volt-amp. Two or more units may be connected in parallel for greater outputs; whilst three similar units may be star-connected for use on a three-phase supply.

The additional circuit shown dotted in Fig. 4 is designed to provide a stable undistorted output voltage to a constant load of fixed resistance connected to terminals X and Y. The unit may be designed for loads of 60 to 180 W. On the designed load the variation of output voltage is no more than 0·04% for 1% change of supply voltage within a range of 200/250 volt; with no more than 0·05% change of output voltage for 1% change of frequency within a range of 48/32 cycles per second.

Fig. 5 shows a voltage stablizer ciruit designed to compensate for changes of supply voltage or load. The transformer T has its primary and secondary windings connected in series to boost the supply voltage. At normal supply frequency the capacitor C and reactor L form a parallel resonating circuit, in which the current merely pulsates between L and C, the only energy taken from the line then being that required to make good the losses in L and C. This circuit then acts as a high resistance in series with the primary windings of T.

Increase of load current increases the current through the primary windings of T, thus increasing the flux density in the core of T and increasing the secondary voltage to compensate for the increased impedance volt drop in T. The opposite effect occurs on reduced load, and in this way the output voltage is stablized on varying loads.

On normal voltage the core of the reactor L is partly saturated; thus if the line voltage increases the increased flux density in its core reduces the impedance of its coil. The L-C combination then falls out of resonance and this circuit then constitutes an inductive circuit in series with the primary windings of T, which reduces the secondary voltage of T to stablize the output voltage. On the other hand if the supply voltage falls the reduced core saturation of L increases the impedance of its coil and reduces the coil current. The L-C combination then acts as a capacitor in series with the primary windings of T; partly compensating for the impedance of its primary windings so that the secondary voltage rises. Such regulators are available in sizes up to about 5 kVA and will maintain the output voltage within $\pm$ 1% for $\pm$ 10% change of supply voltage to the unit.

Voltage Surge Indicator

A new light-weight pocket-size voltage surge indicator Type FB30 Form A1, from the Electronic Apparatus Division of Associated Electrical Industries Limited, New Parks, Leicester, has its own battery for on-the-spot checks of voltage surges likely to be harmful to electrical and electronic equipment during manufacture, installation, commissioning and maintenance. Until recently it has not been realised by design engineers that semi-conductor devices are extremely sensitive to these transient surges.

Measurement of the surge amplitude is accurate to within $\pm$ 10% for surges longer than 0.5 microseconds duration and for voltages from 100 V to 1.5 kV. In addition to measuring surges, the instrument can be used where a pocket meter is required as a simple peak voltmeter for either a.c. or d.c. The U.K. price is £21 10s. 0d.

Spheroidal Graphite Cast Iron and Its Applications—II

In our October issue the author reviewed the mechanical properties of S.G. cast iron. He now concludes with a discussion of methods and applications in relation to manufacturing processes

By G. FITZGERALD-LEE, F.R.S.A., M.I.E.I., A.R.Ae.S.

DUE to its castability and good mechanical properties, ductile iron is well suited to the production of pressure castings of many kinds, and its resistance to mildly corrosive conditions makes it very suitable for marine parts such as ship-board valves. As with all castings, those made in ductile iron should be free from sudden changes in section, and the design should be so that progressive solidification from thinner to thicker sections and through them into the feeders, occurs. The pattern-making contraction allowance depends largely, as usual, on the design of the castings, the composition of the material and the heat-treatment; as a general rule, however, patterns for pearlitic ductile iron castings, as cast or normalized, should have contraction allowances ranging from 1 in 80 to 1 in 100 parts; for ferritic, annealed, material, from 1 in 120 parts to nil, and for austenitic high-alloys, from 1 in 50 to 1 in 60 parts. As with ordinary cast irons, the chillers can be positioned at the mould surfaces to cause selective rapid cooling helping to produce sound castings, or to provide zones of considerable hardness for withstanding particularly severe wear during service life.

All the usual heat-treatments can be applied to ductile iron and the addition of 1% to 2% of nickel helps to produce the best yield and tensile strengths and hardening in pearlitic material and the best mechanical properties of ferritic, annealed, material without impairing its ductility. Stress relief, which does not appreciably affect mechanical properties and is especially useful in the case of complex castings, is effected by soaking for a few hours at 500° to 550° C. Annealing to the fully ferritic condition is achieved by soaking the metal for 1 to 4 hr at 850° to 900° C, then cooling slowly in the furnace to 650° C, and withdrawing. If the rate of cooling between 800° and 700° C is not slow enough to give a fully ferritic structure, the material can be held at the lower temperature for up to 8 hr before further cooling and withdrawal, which gives maximum ductility and toughness.

Normalizing is effected by soaking for 1 to 4 hr at 850° to 900° C— as for annealing—then withdrawing at 800° C to cool in air. This gives high strength together with good ductility, shock resistance and hardness. After soaking at the annealing and normalizing temperature for the appropriate period, the material can be quenched in warm oil, resulting in high mechanical properties and hardness. For tempering after hardening, the metal is soaked at from 200° to 600° C, depending on the required properties, as shown in Table II.

In order to obtain the maximum hardness through any section, ordinary ductile iron is austenized by soaking it for up to 2 hr at 850° C, quenching, then tempering at 350° C for 1 hr. This results in a yield strength of 55 ton/in²., tensile strength of 65 ton/in².—equal to high-tensile steel—elongation of 1%, and Brinell hardness of 400. Normalizing at 850° C for 2 hr gives a hardness of 300 B.H.F.—with yield strength of 45 ton/in². and tensile strength of 55 ton/in². As has been indicated, ductile iron responds to flame and induction hardening. For effecting the hardest surface to the greatest depth, the castings should contain 1·5% to 2% of nickel and be in the pearlitic condition, when a hardness of up to 750 B.H.F.—very much higher than that of white cast iron—can be developed to a depth of 0·1 in. If the metal is ferritic instead of pearlitic the response will be less unless repeated or extended heating is effected before quenching. As already mentioned, ductile iron can, like ordinary cast iron, be given very hard surfaces by using chillers in the mould; in such cases the graphite in the grey cast iron under the chilled surface will, on solidification, be spheroidal and will have the high mechanical properties of all ductile irons. In these cases the castings are put into service 'as cast' or stress-relieved only, as higher temperature treatment will alter the white-iron layers formed in the casting. Ductile irons can also, like other ferrous metals, be nitrided, or nitrogen-hardened.

When annealed, ductile iron can be cold-worked within limits, sheared or punched. It can also be machined, due to the large amount of spheroidal graphite in its structure, but it requires more power than for grey cast iron of the same hardness or steel of the same strength. The ferritic type can be machined wet or dry at high speed with only slight tool wear, producing continuous turnings. Ductile iron can also be ground or honed to give excellent surface finish. The tools used can be of high-speed steel or cemented carbide, but with the latter the grade used is important: if it is too hard, the cutting edge may chip; if it is too soft it will wear quickly. The whole job should, of course, be perfectly rigid;

Table IV.—SPEEDS FOR MACHINING DUCTILE IRON, FT. PER MIN.

	Turning	Drilling	Reaming	Tapping	Thread Chasing	Milling	Shaping and Planing	Broaching
Annealed, with fully ferritic matrix	50–150	80–130	50–100	20–30	30–70	50–125	40–100	20–35
Semi-pearlitic matrix	40–90	50–100	40–70	15–20	20–50	35–65	30–75	15–25
As cast, with fully pearlitic matrix	40–90	50–70	40–70	15–20	20–50	35–65	30–70	15–25
a. High-speed steel tools.								
Annealed, with fully ferritic matrix	175–400	—	75–150	—	—	200–400	—	—
Semi-pearlitic maxtrix	100–300	—	50–90	—	—	175–350	—	—
As cast, with fully pearlitic maxtrix	100–300	—	50–90	—	—	175–350	—	—
b. Cemented-carbide tools								

the first cut must be deep enough to avoid tool abrasion by the casting 'skin', and the remainder deep enough to prevent the tool riding over the work-hardened surface. Table IV shows suitable cutting speeds, the lower ranges of which give increased tool life between grinds. Ductile irons can be ground and honed but the choice of wheels and hones is a matter for consultation between the suppliers and users of the abrasives.

Metallic arc welding is the best means of joining ductile iron either to itself or to other metals. Electrodes with core wires of 55% nickel-iron alloy should be used, resulting in a machinable weld the strength of which is comparable to the parent metal. It is likely that there will be a narrow, hard zone on each side of the weld which can, if required, be eliminated by annealing the joint after welding or tempering at from 550° to 700° C. There is no need to preheat the ferritic grade of ductile iron before welding, but the pearlitic grade should be preheated at about 200° C. In oxy-acetylene welding, the same technique as for flake-graphite cast iron should be used, the filler rods being of ductile iron. The material can also be bronze-welded and silver soldered, and it is easier to overlay a hard surface or coating on ductile iron than on flake-graphite cast iron. In order to improve corrosion-resistance, ductile iron can be galvanized or electroplated; hard chromium can be deposited on its surface for improving abrasion-resistance, and it can be tinned or vitreous enamelled.

The versatile material is used as cast for low-pressure steam turbine casings, turbine and engine base plates; compressor bodies and cylinders; flywheel couplings; hearth plates, furnace skids; internal combustion engine crankshafts; packaging machine bearings; pneumatic tool bodies, vice bodies; machine tool beds, frames, saddles, carriages, tool blocks and holders, boring machine columns, shaper heads, large spindles, cranks, saw beds and hydraulic work clamps.

In the normally annealed state its applications include water turbine castings, Francis wheels, control rings, low-pressure steam turbine casings, steam turbine diaphragms, gas turbine compressor casings, free piston engine valve belts, turbine and engine base plates; compressor bodies and heads; couplings for condenser water boxes, flywheels, gear wheel centres and spiders, gear cases, boiler soot blower nozzles and refractory wall hangers; furnace grates and firebars, furnace doors and frames, boiler segments, burner bodies, hearth plates, flue dampers and pipes, furnace skids, stove parts and tops, tuyeres, boiler tube supports and superheater spacers, glass moulds, catalyst support grids, refractory wall hangers; internal combustion engine frames, bodies, blocks, crank cases, cylinder liners and heads, pistons and piston heads, connecting rods and straps, rocker arms, fuel injector bodies, exhaust manifolds, flywheels, starter housings, bearing caps, water pump bodies; gas turbine bearing support rings, flame tube support rings, hot air valves, manifolds and de-icing distributor rings; cash register, typewriter and lawn mower frames, conveyer frames and brackets, elevator buckets, gear casings, light gears, hoist blocks; textile machinery levers, brackets, links, guides, roller ends; packaging machinery levers, lock details, door hinges, fan hubs, mincer bodies and worms; C-clamps, air hose couplings, brace parts, vice bodies; machine tool chuck bodies, face plates, tool shanks, cutter heads, die plates, clamps, vice frames and jaws, gear cases, handles, levers, index wheels, collets, shaper and turret heads and hydraulic work clamps.

When in the annealed high-ductility condition ductile iron is used for gas turbine bearing and flame tube support rings, hot air valves, manifolds and de-icing distributor rings. As cast and stress relieved it is used for Pelton and Francis wheels; compressor pistons and cylinders; couplings for boiler feed pump bodies and impellers; internal combustion engine frames, bodies, blocks, crank cases, bearing caps, hydraulic coupling rotors and covers; laundry ironer beds, rubber goods moulds and dies; packaging machine bearings; frames and jigs, pneumatic tool bodies; machine tool clutch bodies and plates and also gears and racks.

Normalized ductile iron finds its best applications in Pelton and Francis wheels; compressor pistons, cylinders and crankshafts; glass moulds; internal combustion engine cylinder liners, pistons and piston heads, crankshafts, timing gears, connecting rods and straps, starter gears, bearings, clutch bodies and plates, hydraulic coupling rotors and covers; piston engine control ring gears for propellers; rubber goods moulds and dies, hoist and elevator gears and sheaves; textile machinery levers, brackets, links, guides, cams, gears, thread guides, picking buffers and eccentrics; packaging machinery gears; spanners, box spanners, gauges, frames and jigs, hammer heads; machine tool beds, frames, saddles, carriages, clutch bodies, clutch bodies and plates, gears and racks, cams, templates, tool blocks and holders, boring machine columns, large spindles, turret heads and cranks.

In the quenched and tempered condition its uses include compressor crankshafts; internal combustion engine piston rings, timing gears; hoist and elevator gears and sheaves; textile machinery cams and gears, thread guides, picking buffers and eccentrics; packaging machinery gears and cams; chisels and axes. The surface-hardened grade is especially for couplings for boiler soot blower nozzles and refractory wall hangers; internal combustion engine crankshafts and cams, rocker arms; textile machinery cams and gears; packaging machinery cams; chisels, axes and machine tool cams.

Austenitic ductile irons, of the Ni-Resist type, are for couplings for condenser water boxes and boiler feed pump bodies and impellers; stove parts and tops, tuyeres, boiler tube supports and superheater spacers; internal combustion engine exhaust manifolds and turbo-charger turbine casings, rotors and manifolds; gas turbine hot air valves and manifolds; and piston engine exhaust manifold swivel couplings. Further to which special compositions of the irons with specific heat-treatments are developed for special purposes.

This is by no means a complete list of all the applications of ductile iron. The many other uses concern electrical, automobile, transport, mining, foundry, chemical, process, civil, argricultural and marine engineering.

Higher Rectifier Ratings

Following extensive life tests over a period of years, Westinghouse Brake and Signal Company Limited announce improved voltage ratings of the 26 amp CS31, and 16 amp CS32 ranges of Trinistor silicon controlled rectifiers. All S.C.Rs in these ranges may now be operated at a non-repetitive transient voltage of 1·4 times the previously published ratings. Thus a CS31N or CS32N Trinistor may be operated at a recurrent peak voltage of 400 volt and will withstand non-repetitive transient voltage peaks of 560 volts.

Nuclear Fuels for Power Stations

The conclusion of a two-part article dealing with the types and properties of nuclear fuels

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5. Physical properties of nuclear materials

5.1. Atomic structure

The atom consists of a central nucleus of protons with positive electrical charge and uncharged neutrons, around which, and at relatively great distances away, negatively charged electrons revolve in orbits. In the neutral atom the number of electrons balances the number of protons in the nucleus. The number of protons in the nucleus is known as the atomic number of the element and this determines its chemical properties. Nuclei of the same atomic number have the same chemical properties, irrespective of the number of neutrons within the nucleus. They occupy the same place in the periodic system and are known as isotopes. The sum of the protons plus neutrons within the nucleus gives the mass number or atomic weight of the isotope.

5.2. Elementary particles

These are indicated in Table VI to which the hydrogen atom has been added for comparison.

It will be seen that:

(a) the electron and proton have equal and opposite elementary charges of electricity, while the neutron is uncharged

(b) the size of the elementary particles are all about the same, i.e., 10^{-13} cm

(c) the atomic weights of the proton, the neutron and the hydrogen atom are about the same

(d) the ratio of the atomic weight of a proton to that of an electron is 1865·9, and of a neutron to an electron 1868·2

(e) the diameter of the hydrogen atom, consisting of one proton and one electron, is nearly 100,000 times larger than a proton or a neutron.

5.3. Nuclear materials

The physical properties of the most important nuclear fuels and associated materials are summarized in Table VII. The numerical ratio of neutrons to protons is indicated in column 9. These values for U238, Th232 and Pu239 are 1·587, 1·634 and 1·543 respectively. The half life, density, melting and boiling points are contained in columns 10, 11, 12 and 13.

The melting point of the principal nuclear fuels is of particular interest. The values are arranged in groups of metallic and ceramic fuels in Table VIII.

It is apparent from Table VIII that to obtain optimum operating fuel temperatures it is necessary to use ceramic fuel. The most favoured fuel at the moment is uranium dioxide for it is used in the reactors of seventeen nuclear power stations. Enriched uranium monocarbide has only been applied to the 15 Mw(e) nuclear power station at Stetternich, near Julich, west of Cologne, Germany. Only one station is fuelled with a mixture of UO_2 and ThO_2. This is Indian Point, near New York, with net electrical capacity of 255 Mw(e) and a net thermal efficiency of 31.91 %.

Table VI

1	2	3	4	5
	Charge (Coulomb = Ampere-second)	Mass gm	Mass number (atomic weight)	Dia cm
Electron	$-1{\cdot}59 \times 10^{-19}$	$0{\cdot}00090 \times 10^{-24}$	0·00054	$3{\cdot}7 \times 10^{-13}$
Proton	$+1{\cdot}59 \times 10^{-119}$	$1{\cdot}6720 \times 10^{-24}$	1·0076	approx. 10^{-13}
Neutron	0	$1{\cdot}6740 \times 100^{-24}$	1·0088	,, 10^{-13}
Hydrogen atom	0	$1{\cdot}6724 \times 100^{-24}$	1·0078	$1{\cdot}08 \times 10^{-8}$

Table VIII

Group	Nuclear fuel		Melting point °C	Melting point °F
a	Metallic	U238	1150	2102
		Thu232	1845	3353
		Pu239	632	1169
b	Ceramic	UO_2	2750	4982
		UC	2350	4262
		ThO_2	3050	5522

Table VII—A SUMMARY OF ESSENTIAL PARTICULARS OF THE PROPERTIES OF NUCLEAR MATERIALS

1	2	3	4	5	6	7	8	9	10	11	12	13
				Number of							Temperature	
Item	Nuclear materials	Chemical symbol	Atomic number	Protons	Neutrons	Protrons plus neutrons	Atomic weight	Ratio of neutrons to protons	Half life (y = years)	Density	Melting point °C	Boiling point °C
1	Uranium 234	U234	92	92	142	234	234·17	1·544	$2{\cdot}48 \times 10^{5}$y			
2	Uranium 235	U235	92	92	143	235	235·12	1·554	$7{\cdot}10 \times 10^{8}$y			
3	Uranium 238 (white metal)	U238	92	92	146	238	238·12	1.587	$4{\cdot}49 \times 10^{9}$y	18·68	1150	3818
4	Uranium dioxide	UO_2	—	—	—	—	270·07	—	—	10·96	2750	
5	Uranium trioxide	UO_3	—	—	—	—	286·07	—	—			
6	Tri-uranium oct-oxide	U_3O_8	—	—	—	—	842·21	—	—		2500	
7	Uraniun monocarbide	UC	—	—	—	—	250·13	—	—	13·62	2350	
8	Uranium dicarbide (gray)	UC_2	—	—	—	—	262·09	—	—	11·28	2500	4100
9	Uranium tetra flouride	UF_4	—	—	—	—	314·07	—	—			
10	Uranium hexafluoride (yellow)	UF_6	—	—	—	—	352.07	—	—	4·68		
11	Uranyl nitrate hexahydrite	$UO_2(NO_3)_2\,6\,H_2O$	—	—	—	—	502·18	—		2·85		
12	Thorium 232	Th232	90	90	142	232	232·00	1·634	$1{\cdot}39 \times 10^{8}$y	11·55	1845	4500
13	Thorium dioxide	ThO_2	—	—	—	—	264·12	—	—	11·01	3050	4400
14	Thorium dicarbide	ThC_2	—	—	—	—	256·14	—	—	10·65	2775	5000
15	Plutonium 239 (fissionable)	Pu239	94	94	145	239	239·13	1·543	24,100y	19·51	632	3335
16	Plutonium 240 (non fissionable)	Pu240	94	94	146	240	240·13	1·553	6,580y			
17	Plutomiun 241 (fissionable)	Pu241	94	94	147	241	241·13	1·564	14y			
18	Plutonium 242	Pu242	94	94	148	242	242·13	1·575	$5{\cdot}0 \times 10^{5}$y			
19	Plutonium 243	Pu243	94	94	149	243	243·14	1·585	5 hours			
20	Plutonium dioxide	PuO_2	—	—	—	—	271·13	—	—	10·01	2280	

5.4. Isotopes

The number of neutrons and the half life of fourteen uranium, twelve thorium and eleven plutonium isotopes are in Tables IX, X and XI. It should be noted the U238 and Th232 are fertile and U233, U234, U235, Pu239 and Pu241 fissionable materials.

5.5. Thermal conductivity

Data are given in Table XII at various temperatures for U238, UO_2, UC, Th232, ThO_2 and Pu239. The ratio of the thermal conductivity relative to U238 for temperatures of 100° C to 1000° C are presented in Table XIII. The conductivities of UO_2 and ThO_2 are very much lower than U238, therefore it is essential to reduce the diameter of the fuel to about 0·4 in. which adds to the cost of fabrication. However, the melting point of UO_2 is much higher than for U238, consequently reactors using it can operate at greater fuel temperatures.

Table IX.—ISOTOPES OF URANIUM

Uranium		
Atomic number 92 No. of isotopes = 14		
Isotope	Number of neutrons	Half life
U227	135	1·3 m
U228	136	9·3 m
U229	137	58·0 m
U230	138	20·8 d
U231	139	4·2 d
U232	140	70·0 y
U233	141	$1{\cdot}62 \times 10^{5}$ y
U234	142	$2{\cdot}48 \times 10^{5}$ y
U235	143	$7{\cdot}10 \times 10^{8}$ y
U236	144	$2{\cdot}46 \times 10^{7}$ y
U237	145	6·63 d
U238	146	$4{\cdot}498 \times 10^{9}$ y
U239	147	23·5 m
U240	148	18 m

m = minutes d = days h = hours y = years

Table X.—ISOTOPES OF THORIUM

Thorium		
Atomic number 90 No. of isotopes = 12		
Isotope	Number of neutrons	Half life
Th223	133	0·1 sec.
Th224	134	1·05 sec.
Th225	135	8·0 m
Th226	136	30·9 m
Th227	137	18·6 d
Th228	138	1·9 y
Th229	139	7340 y
Th230	140	8×10^{4} y
Th231	141	25·6 y
Th232	142	$1{\cdot}39 \times 10^{8}$ y
Th233	143	23·5 m
Th234	144	24·10 d

m = minutes d = days h = hours y years

Table XI.—ISOTOPES OF PLUTONIUM

Plutonium		
Atomic number 94 No. of isotopes = 11		
Isotope	Number of neutrons	Half life
Pu232	138	36 m
Pu234	140	8·5 h
Pu235	141	26·0 m
Pu236	142	2·7 y
Pu237	143	40·0 y
Pu238	144	92·00 y
Pu239	145	24,100 y
Pu240	146	6,580 y
Pu241	147	14 y
Pu242	148	5×10^{5}y
Pu243	149	5 h

m = minutes d = days h = hours y = years

5.6. Mean linear thermal expansion

These are contained in Table XIV for various temperatures based on a room temperature of 25° C. The values for UO_2, UC and Th232 are much lower than for U238.

5.7. Mechanical properties at room temperature (25° C)

These are indicated in Table XV for U238, Th232 and Pu239.

5.8. Some comparative fuel data

The relative merits of the various types of nuclear fuels can only be assessed by making a comparison of their essential characteristic values. Such detailed information for the principal nuclear fuels is summarised in Table XVI which reveals:

(a) the maximum operating fuel temperature for U238 is 550°C (1022° F) whilst for UO_2 and UC it is 1400° C (2552° F), i.e., 2·546 times greater.

(b) the ratio of the maximum operating temperature to the melting point of the nuclear fuel is 0·4783 for U238, 0·5091 for UO_2 and 0·5957 for UC.

Table XII—THERMAL CONDUCTIVITY OF NUCLEAR FUELS AT VARIOUS CENTIGRADE (Units: gcal/cm°C sec)

1	2	3	4	5	6	7
Nuclear fuel	Degree centigrade					
	100	200	400	600	800	1000
U238	0·067	0·070	0·076	0·084	0·086	0·089
UO_2	0·022	0·014	0·011	0·008	0·007	0·005
UC	0·065	0·056	0·051	0·049	0·0485	0·048
Th232	0·090	0·093	0·100	0·106	—	—
ThO_2	0·036	0·022	0·014	0·010	—	0·007
Pu239	0·011	—	—	—	—	—

Table XIII—RATIO OF THERMAL CONDUCTIVITY RELATIVE TO URANIUM 238 AT VARIOUS TEMPERATURES

1	2	3	4	5	6
	Ratio				
Temperature °C	UO_2/U238	UC/U238	Th232/U238	ThO_2/U238	Pu239/U238
100	0·3283	0·9707	1·343	0·5371	0·1642
200	0·200	0·8000	1·328	0·3142	—
400	0·1447	0·6711	1·316	0·1842	—
600	0·0952	0·5833	1·0262	0·1189	—
800	0·0814	—	—	—	—
1000	0·0562	0·5371	—	0·0798	—

Table XIV—MEAN LINEAR THERMAL EXPANSION FROM ROOM TEMPERATURE OF 25° C AT VARIOUS TEMPERATURES ($\alpha \times 10^{6}$)

1	2	3	4	5	6	7
Nuclear fuel	Temperature °C					
	100	200	300	600	800	1000
U238	21·7	23·0	30·0	36·7	—	—
UO_2	9·2	9·2	9·2	10·8	11·8	12·9
UC	—	—	—	—	—	10·5
Th232	11·55	11·55	11·75	12·0	12·3	12·65
ThO_2	—	—	—	—	—	9·5
Pu239	55·0					

Table XV—MECHANICAL PROPERTIES OF NUCLEAR FUELS AT ROOM TEMPERATURE (25° C)

1	2	3	4	5	6	7
Nuclear fuel	U.T.S. psi	Y.P. psi	Young's tensile modulus $E \times 10^{-6}$ psi	Shear modulus $G \times 10^{-6}$ psi	Elongation %	Poisson
U238	110 500	43 000	29·1	11·9	6·8	0·20
Th232	30 600	22 400	10·0	4·0	10·6	0·27
Pu239	62 800	39 300	14·4	6·29	—	0·15

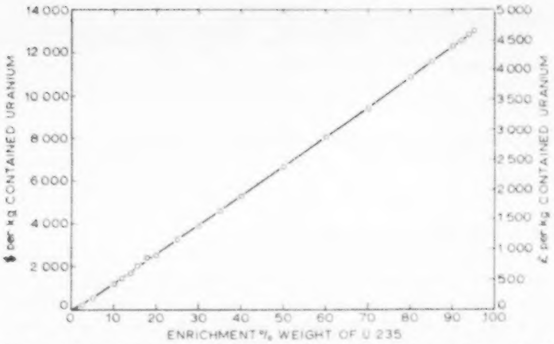


Fig. 1.—U.S.A.E.C. charges for enriched uranium fuel (U235) revised on July 1, 1961. Based on $8/kg for ore concentrates U_3O_8

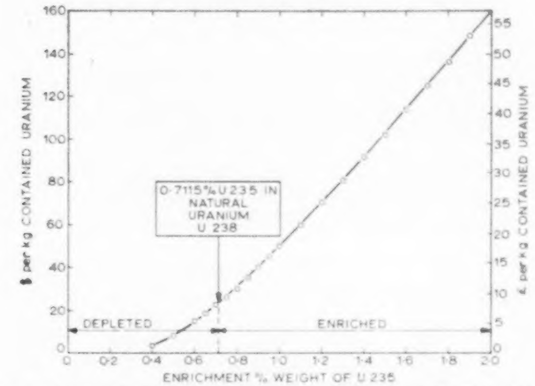


Fig. 2.—U.S.A.E.C. charges for depleted and enriched uranium U235. Revised on July 1, 1961. Based on $8/kg for ore concentrates U_3O_8

Table XVI—COMPARATIVE NUCLEAR FUEL DATA

	Natural uranium (U238)	Uranium dioxide (UO_2)	Uranium monocarbide (UC)
1 Density	18·68	10·96	13·62
2 Melting point °C	1 150	2 750	2 350
°F	2 102	4 982	4 262
3 Maximum operating °C	550	1 400	1 400
temperature of fuel °F	1 022	2 552	2 552
4 Ratio of maximum operating temperature to melting point.	0·4783	0·5091	0·5957
5 Thermal conductivity (gcal/cm °C sec)			
(a) 400°C (752°F)	0·076	0·011	0·051
(b) 800°C (1472°F)	0·086	0·007	0·0485
(c) 1000°C (1832°F)	0·089	0·005	0·048
6 Mean linear thermal expansion from room temperature of 25 °C			
(a) 400°C (752)°F	30×10^{-6}	$9{\cdot}2 \times 10^{-6}$	
(b) 800°C (1472°F)		$11{\cdot}8 \times 10^{-6}$	
(c) 1000°C (1832°F)		$12{\cdot}9 \times 10^{-6}$	$10{\cdot}5 \times 10^{-6}$

Table XVII—THE U.S. ATOMIC ENERGY COMMISSION'S CHARGES FOR DEPLETED URANIUM FUEL (REVISED ON THE 1ST JULY, 1961.)

1	2	3	4
Enrichment in % weight %	Weight as fraction of U235	Basic charge $/kg U235	Price per gram of contained $/g U235
0·70	0·0070	22·60	3·228
0·65	0·0065	18·60	2·862
0·60	0·0060	14·80	2·466
0·58	0·0058	13·35	2.297
0·56	0·0056	11·95	2·134
0·54	0·0054	10·60	1·963
0·52	0·0052	9·30	1·788
0·50	0·0050	8·05	1·610
0·48	0·0048	6·85	1·428
0·46	0·0046	5·75	1·250
0·44	0·0044	4·70	1·068
0·42	0·0042	3·75	0·893
0·40	0·0040	3·00	0·750

Should the user specify U235 between 0·4 and 0·22% then the charge is $3/kg of contained U235. If the U235 is not specified by the user, the Commission will supply uranium having a U235 content to be determined by the Commission in the range below 0·4% and will charge $2·5/kg of U235.

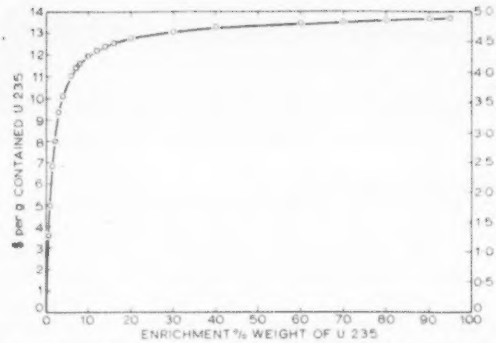


Fig. 3.—U.S.A.E.C. prices per gram of contained U235 in enriched uranium. Revised July 1, 1961. Based on $8/kg for ore concentrates U_3O_8

Table XVIII—U.S. ATOMIC ENERGY COMMISSION'S CHARGES FOR ENRICHED URANIUM FUEL. (AS REVISED JULY 1, 1961)

1	2	3	4
Enrichment in % of weight %	Weight as a fraction of U235	Basic charge $/kg U235	Price per gram of contained U235 $/g
0·75	0·0075	26·70	3·559
0·80	0·0080	31·10	3·887
0·85	0·0085	35·60	4·188
0·90	0·0090	40·30	4·477
0·95	0·0095	45·00	4·732
1·00	0·0100	49·90	4·990
1·10	0·011	59·90	5·445
1·20	0·012	70·20	5·849
1·30	0·013	80·80	6·216
1·40	0·014	91·60	6·543
1·50	0·015	102·60	6·839
1·60	0·016	113·80	7·112
1·70	0·017	125·20	7·365
1·80	0·018	136·60	7·570
1·90	0·019	148·20	7·800
2·00	0·020	160·00	8·000
2·20	0·022	183·60	8·347
2·40	0·024	207·60	8·650
2·60	0·026	232·00	8·923
2·80	0·028	256·40	9·156
3·00	0·030	281·20	9·373
3·20	0·032	306·40	9·574
3·40	0·034	331·00	9·734
3·60	0·036	356·00	9·888
3·80	0·038	381·60	10·030
4·00	0·040	407·60	10·175
4·50	0·045	471·00	10·450
5·00	0·050	535·50	10·710
5·50	0·055	600·50	10·910
6·00	0·060	665·50	11·091
7·00	0·070	797·00	11·386
8·00	0·080	929·00	11·612
9·00	0·090	1062·00	11·800
10·00	0·100	1195·50	11·955
12	0·12	1464	12·20
14	0·14	1733	12·38
16	0·16	2004	12·52
18	0·18	2275	12·64
20	0·20	2547	12·74
25	0·25	3230	12·92
30	0·30	3915	13·05
35	0·35	4602	13·15
40	0·40	5292	13·23
50	0·50	6667	13·33
60	0·60	8066	13·44
70	0·70	9462	13·52
80	0·80	10865	13·58
85	0·85	11575	13·61
90	0·90	12285	13·65
92	0·92	12575	13·67
94	0·94	12865	13·69
95	0·95	13015	13·70

(c) the thermal conductivity of UO_2 is very low when compared with U238. The values of UC are about half those of U238.

6. Prices for reactor materials

Only the United States Atomic Energy Commission has published charges for reactor materials. In 1961 the

Production Practice:

Designing Form Relieved Cutters

By JOHN WALLER

DESPITE its apparent complexity, the form relieved type of cutter is used extensively and though the design of the various parts may differ considerably, they are the basis of such operations as thread milling, hobbing gears, spline cutting, and for cutters in gangs when profile milling is done across a component. All these cutters, however, have one distinctive feature—they all have a curved form running back from the cutting edge which will allow many resharpening operations before the cutter eventually becomes too weak for further use, and this relief, while prolonging the life of a tool, also ensures that it has sufficient clearance as each tooth passes across the workpiece.

A typical tooth shape is shown in Fig. 1 where the shaded portion indicates the circumferential relief which prevents the tool from rubbing as the cutting edge clears the depth of material being removed. The origin of this form milling is attributed to Messrs. Brown and Sharpe of America, and though the process was some time before it became popular throughout the world—notably because of the lack of a suitable relieving lathe to undertake the task—there is no doubt that this style of cutting tool did much to encourage design in the thread cutting and hobbing fields and so make these processes an economic possibility.

Briefly, the operation of relieving these teeth is accomplished in the following manner. A tool is clamped in the usual type of box and the depth of cut is regulated by the usual rotation of a handle, but the cross slide is controlled by a cam which gives it a reciprocating motion as each tooth is presented for relieving. The tool thus advances as the tooth apex is reached and continues to do so until it reaches a tooth space or gash, whereupon it recedes quickly and is ready for the next tooth as it slowly rotates into the required position. The slide thus moves backwards and forwards the same number of times for each revolution of the cutter as there are teeth in the blank, and the depth of the relief is governed by choice of cam installed on the lathe, and which is always quoted in millimetres. This movement of a tool—most of them have some degree of profile or angular form—results in the production of a circumferential relief being machined back from each cutting edge thus creating a spiral shape as the tool tends to approach the centre of the cutter.

Two designs of cam are employed—the "single rise" geared to give the necessary number of movements to the cross slide for every rotation of the machine spindle—and the "multi-rise" which, as the name suggests, incorporates a number of rises on the profile instead of a single protrusion. When the number of rises does not correspond to the number of teeth being machined, then the same procedure of gearing the cam is utilised; thus a cam having four rises would make four revolutions when cutting a tool having 16 teeth.

An archimedean spiral is generally used in preference to the logarithmic spiral, because though it does not possess the equiangular properties of the logarithmic form, the variation is slight and is sufficiently accurate for the relatively small pitches associated with cutter manufacture.

The vast majority of form milling cutters are made with the teeth gashes parallel with the cutter axis and there are perhaps three reasons for adopting this in preference to the spirally gashed type. Ignorance of the methods practiced in calculating the setting details is undoubtedly the chief difficulty when comparatively long form cutters are manufactured, and to this is coupled the added time in setting-up the lathe. Finally there is the problem of checking a spiral form as the inclusion of several blending radii can present awkward moments to the tool inspector, and to the machine operator.

For relieving cutters the saddle is traversed along the machine bed by the action of a screw geared to the head-stock spindle in order to secure the correct lead. The screw is also used to provide a compensating action for spirally gashed teeth as a means of overcoming the difference in tooth spacing as the cutter rotates—Fig. 2. During one complete revolution of the cutter, the relieving tool travels a lateral distance equal to the lead; thus one-eighth of a revolution is equal to one-eighth of the lead. When cutters with straight flutes are produced the tool is presented to the tooth face as each flute turns the eighth of a revolution, but for spiral gashes the cutting face is advanced slightly for each tooth as shown at A,B,C, etc., until the final tooth moves forward approximately a third of a spacing as seen at H.

This angular difference in the spacing is obtained from the formula:

$$\frac{\text{Cos angle of spiral gashing} \times 360 \times \text{normal pitch of cutter}}{\text{Lead of spiral gashes} \times 8 \text{ (or number of teeth)}}$$

Continued from previous page.

Table XIX— U.S. ATOMIC ENERGY COMMISSION'S PRICES FOR REACTOR MATERIALS, 1960

(1)	Thorium	\$43/kg
(2)	Plutonium	\$12,000/kg
(3)	Uranium-233 nitrate (U_3N_4)	\$15 000/kg
(4)	Chemical processing of irradiated fuels (Number of days varies from 4 up to a week depending on the load)	\$16 400 per day
(5)	Conversion charges from UNO_3 to UF_6	
	below 5% enricned	\$5·6/kg
	above 5% enriched	\$32.0/kg
(6)	Fuel shipping costs	
	(a) irradiated fuel	\$16/kg
	(b) non irradiated fuel	\$1·5/kg
(7)	Heavy water	\$28/lb
(8)	Helium	\$11/cubic ft

charges were reduced and the revised price for depleted and enriched uranium fuels are presented in Tables XVII and XVIII and plotted in relation to the enrichment in % of weight of U235 in Figs 1, 2 and 3. The values are based on the revised price of \$8/kg for ore concentrates U_3O_8 which corresponds to a 33% reduction on the original charge of \$12/kg.

and the total angular difference is equal to:-

$$\frac{\text{Cos angle of spiral gashes} \times 360 \times \text{normal pitch of cutter}}{\text{Lead of spiral gashes}}$$

This slight but important difference is easily overcome by increasing the tool movement for each tooth presented, and this is accomplished by speeding the cam driving shaft a fraction for every tooth. Thus if the cutting teeth have been gashed spirally to 50 in. and the cutter

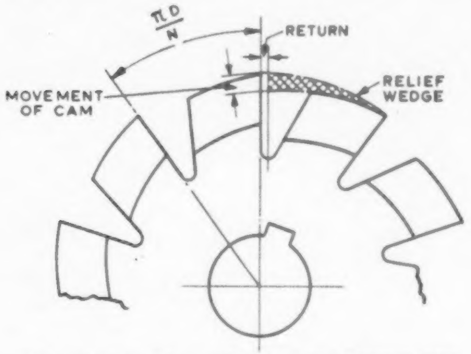


Fig. 1.—Showing metal removed from each tooth in form relieving

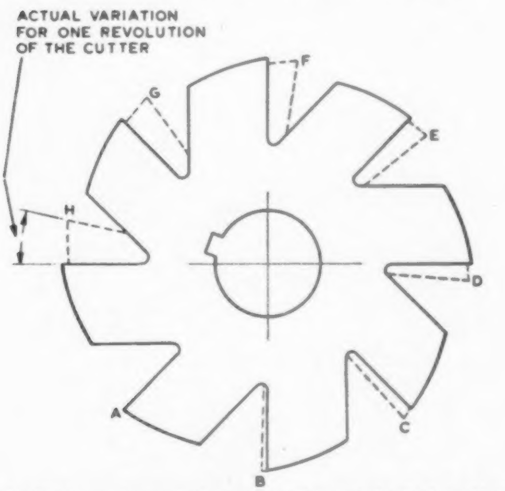


Fig. 2.—The degree of compensation necessary when a spiral cutter is machined

lead is 1 in. then the cam shaft rotates $1^1/_{50}$ turns for every turn of the workpiece.

However, the above method does not apply when cutters have a series of annular rows of teeth which do not form a spiral requiring relieving and in these cases each annular row of teeth is relieved by undertaking the operation as though the cutter were a simple member consisting of a single annular row of teeth. As the cutter does not have a lead, the spacing of each annular row is constant in relation to the tool, but as the spiral gashes have been made, there is a difference in the tooth space relative to the tool between the rows of teeth. Because the angular difference between the rows is constant, the calculation for this is by the formula:

$$\frac{\text{Pitch of cutter} \times 360}{\text{Lead of spiral gashes}}$$

and as the tool is moving laterally, the same alteration to the cam drive is effected to advance or retard the tool and so bring it into correct adjustment.

The relief angle

Reverting to Fig. 1, it is seen that the relief given to a cutter determines the cutting angle and a brief calculation

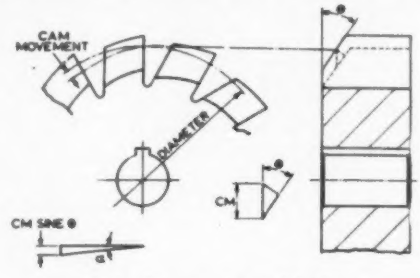


Fig. 3.—Clearance on an angled cutter

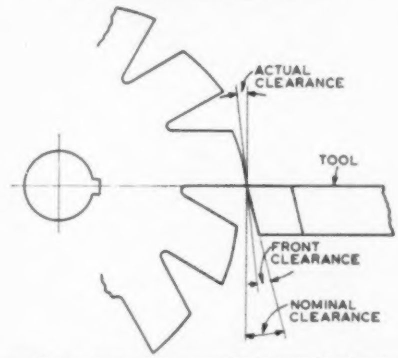


Fig. 4.—Some attention to the clearance angles is essential when considering the tool for machining the relieved profile as too small an angle can cause interference as the cutter rotates

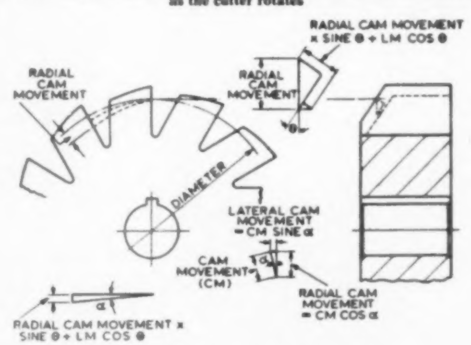


Fig. 5.—Side relief incorporated in a cutter

will show whether the suggested relief is suitable to allow that cutter to operate efficiently. The drawing illustrates the relief as being of a wedge shape with a length equal to a portion of the circumference or $\pi D/N$. This angle is expressed as:-

$$\text{Tan } A = \frac{\text{Cam movement}}{\pi \times D/N} \text{ or } \frac{CM \times N}{\pi D} \text{ where:}$$

Tan A = clearance angle, CM = Cam movement
N = Number of teeth, D = Diameter of cutter.
As the cam throw is expressed in millimetres the formula is written:
Tan $A = (CM \times N)/(25{\cdot}4 \times \pi D)$ and the cam movement could be determined from this by a simple transposition to give:-
$CM = \tan A \times 25{\cdot}4 \times \pi \times D/N$

A calculation made on a cutter where the diameters vary to a considerable extent will reveal that the relief produced at the different diameters varies and the profile machined on the smallest diameter has the greatest relief because the cam movement is constant. This factor can often produce a small, weak looking tooth when the depth of a gashing is severe, and there are occasions when it becomes necessary to manufacture the cutter in two-part form and use angular gashing.

Angular cutters—and thread cutters are a typical example—have a slightly modified form of relief when compared with profiles machined parallel to the cutter axis, and this is seen in Fig. 3. The enlarged drawing shows a triangle where the linear dimension normal to the form is determined by:

Cam movement $\times$ sin θ, and the relief angle is then:

$$\text{Tan } B = (N \times CM \times \sin\theta)/(25{\cdot}4 \times \pi D)$$

This immediately reveals that the relief circulated in this manner is somewhat smaller than that imparted to a cutter when the profile is parallel to the axis. Again, as the relieving machanism imparts a constant relief to the cutter while the circumferential relief will vary as the diameter is decreased, the angle of relief will increase in size as the profile nears the cutter axis. Cutters similar to those shown in this illustration, but having almost vertical sides, will frequently require a greater normal relief to avoid a possible rubbing action. A difficulty may arise in these instances because the cutting edge of the form tool machining the relief as shown in Fig. 4 is seriously weakened as the front clearance angle is cut back to allow it to clear the relieved portion of the tooth.

In many cases side relief is possible by again making the cutter in two parts, and for this operation the reciprocating slide is rotated from being at right angles to the cutter axis, to a position where the relief is needed. This angular setting depends on the relief angle required, and a reference to Fig. 5 indicates that this radial movement is less than the normal cam throw.

Thus if α be the cross slide angle, then the radial movement is:

Cam movement $\times$ cos α

and the actual cam movement for such a relief angle is:

$$\text{Cam movement} = (\tan A \times 25{\cdot}4 \times \pi \times D)/(\cos\alpha\, N)$$

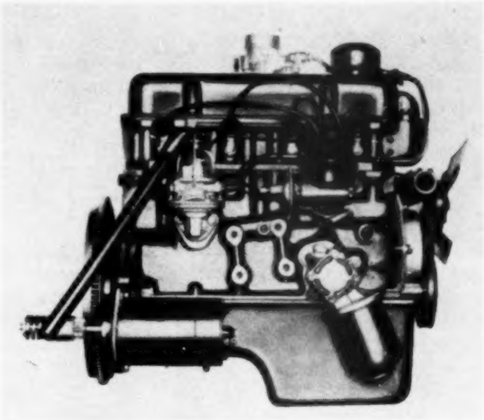
A perusal of this figure will show that the cam movement in relation to the plane of rotation at any point chosen along the angular face of a cutter when determined as a linear dimension normal to the form, is equal to the degree of clearance obtained due to the radial movement of the lathe cross slide with the additional clearance which occurs as the slide moves in a lateral direction. This clearance is expressed as follows:

$$C \sin\alpha \cos\alpha + C \times \cos\theta \sin\theta$$

From this the angle of normal relief obtained from the same position is:

$$\text{Tan } \alpha = (\sin\theta \cos\alpha + \cos\theta \sin\alpha) \times CM/\pi D$$

Unlike the form ground cutters the form relieved member is resharpened on the front face and the curved profile is not again touched once the tool has been hardened, but the operation of grinding is important because the wheel must produce a face radial to the cutter axis if the cutter is to reproduce the form imparted to it during the relieving stage. Again, spirally gashed cutters must, in addition to a correctly ground radial surface, also have the teeth ground at the same spiral angle as any serious deviation from this form of gashing can shorten the working life of a cutter and could at the same time defeat the object for which the spiral teeth were originally provided. Frequent regrinding to remove a small portion from the face rather than a deep section, is essential in prolonging the life of a gang, coupled with the fact several light passes of the wheel is preferable to one or two heavy cuts as the latter can burn the edges and so tend to soften the cutting edge of one or several teeth—creating a situation which naturally destroys the tool before it has had the opportunity to finish the required batch of work.



New 115E, 1·2 litre 48½ bhp petrol engine

New Ford 1.2 Litre Power Unit

The Industrial Engine Division of the Ford Motor Company Limited announce the addition of another new power unit, following close on the heels of the recently announced new 1½ litre unit (122E Series). This latest engine to be produced by Ford of Britain is a four-cylinder 1·2 litre petrol engine designated 115E Series. Developing 48·5 bhp at 4800 rpm (automotive net) the 115E Series basic design follows a similar pattern to the time-proven 105E (997 cc) Series power unit being of similar "over-square" specification. The cylinder block has a cast integral bore and crankcase construction and the cast iron cylinder head has vertical valves and separate intake and exhaust ports.

The range of Ford power units has proved to be extremely popular with manufacturers of various kinds of machinery, and owners of special sports and racing cars and motor boats, and the new 115E is likely to arouse considerable interest in this specialized market. Technical specification of the 115E is as follows:

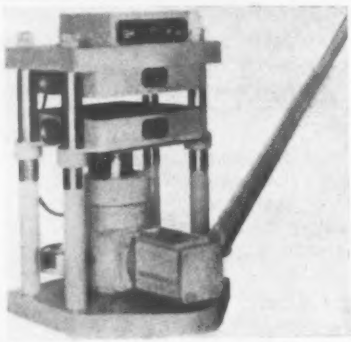
Bore	3·19 in.—80·96 mm
Stroke	2·29 in.—58·16 mm
Swept volume	73·09 cu in.—1198 cc
Comp. ratio	8·7:1
Max. bhp	
Automotive net	48·5 at 4800 rpm
B.S. overload	34·7 at 3000 rpm
B.S. rating	31·5 at 3000 rpm
Max. torque	
Automotive net	63 lb/ft at 2700 rpm
Weight	220 lb
Height	23 in.
Width	17·55 in.
Length	22·01 in.

compactly housed in a console about 122×61 cm and 91 cm high.

Machine Tool Record

Moulding Press

The new Saunders 2A hydraulic moulding press is suitable for all processes where a combination of pressure and heat is required. It can be used for metal, rubber, plastics and bonded laminates. Pressure is provided between two electrically-heated platens. Each consists of a box casting 12 in. square and 2 in. deep, with ample webs which not only reinforce the casting but also distribute the heat generated. Two 375 W electric elements are placed laterally and equidistant within each platen. Sensitive bi-metal thermostats, fully-automatic and infinitely variable, are inside both platens to ensure any required temperature. Automatic temperature indication is provided by two pilot lights which are illuminated when the current is switched on, and are extinguished when the platens reach the pre-set temperature. Two bi-metal, co-axial dial thermometers, with a range of between 100° and 400° F, are fitted to the platens for checking purposes. A special Tangye hydraulic jack, built into the all-steel press framework provides the pressure. A 4 in. dial pressure gauge is fitted for sensitive pressure control. Makers are N. Saunders (Metal Products) Limited 127, Munster Road, London SW6.



The new Saunders press is suitable for moulding metal, rubber, plastics and bonded laminates. Electric heating of the platens is under thermostat control and pressure is applied by built-in Tangye hydraulic jack

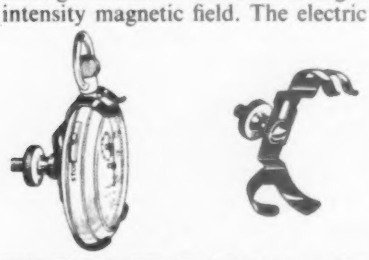
Electromagnetic Forming Machine

The first public demonstration in Europe of a new machine that employs lightning-fast bursts of electromagnetic force to shape, attach and assemble metals was given at the Metz International Fair. Known as Magneform and made by General Atomic Division of General Dynamics Corporation and General Atomic Europe, the machine uses pressures ranging up to 3,550 kg per sq cm (50,000 psi) to shape, compress, expand, swage, emboss, blank, sheer, coin, and assemble electrically conductive metals of light to medium gauge. These pressures are applied in pulses of 10 to 20 millionths of a second duration.

Electrical energy is stored in a capacitor, then discharged suddenly through a coil to establish a high-intensity magnetic field. The electric current induced in a piece of conductive metal placed in, around or near the coil causes the metal work piece to be repelled from the coil with tremendous force which changes the shape of the piece.

Three basic coils control and direct the metal-shaping electromagnetic forces. A circular coil, for radial compression, is used in swaging, joining and assembly operations Another coil delivers the electromagnetic forces from the inside to expand metal, and the third coil is used to form flat pieces.

With these three basic coils, and by adjusting the power level, a wide variety of operations can be performed. Aluminum tubing can be shaped into precise and difficult shapes which cannot be achieved by extrusion or other means. Fittings, connections and retaining rings can be swaged rapidly and firmly. Tubing can be expanded into bushings, hubs and split dies and metal can be fitted around the irregular contours of ceramic parts. Inserts, fittings, terminals, and collars can be swaged on to many diverse parts, and irregular shaped components of a product—an electric motor, for example—can be assembled and "packaged" rapidly and easily in a tight, compact unit. The machine is



STOP-WATCH CLIP.—Specially for use on time and motion study boards, this clip can be adjusted to most sizes of stop-watch and only needs a small hole drilled in the board to fix it. Made by Herbert Terry & Sons Limited, Redditch, it retails at 3/-

Automatic Air Feed Drill

A new automatic tool with air feed introduced by Desoutter Brothers Limited, Hendon, has a completely automatic cycle, a new motor, detachable hydraulic control unit, and complete mounting system. The motor produces within the same diameter over twice the power of its predecessors. The automatic governor maintains the motor at constant speed whether it is running light or under full load. All the motors and gearboxes are the same length, can be separated from one another and are quickly interchangeable. The new tangential blade layout results in less wear and gives several times normal running life. Chucks are taper mounted for accuracy on spindles provided with double row ball races. The control head only needs one air connection and contains all its own valves giving the tool a completely automatic cycle. The design of the control head is such that even in a multiple drilling arrangement where a number of tools are connected together to one starting valve, each tool can still be tried independently of the others by pressing its own starting button. A small signal of air is all that is needed to operate a shuttle valve in each tool head, thus opening the main air supply to each motor. This means that a number of tools can be started simultaneously by one valve of small capacity. The hydraulic unit, needed at such times as when breaking through or when drilling through a cross hole, is quickly detachable and it has its own fine feed adjustment on the outside. A complete system of tubes, clamps and different mounting brackets is available so that a number of tools can be mounted together at any desired angle.

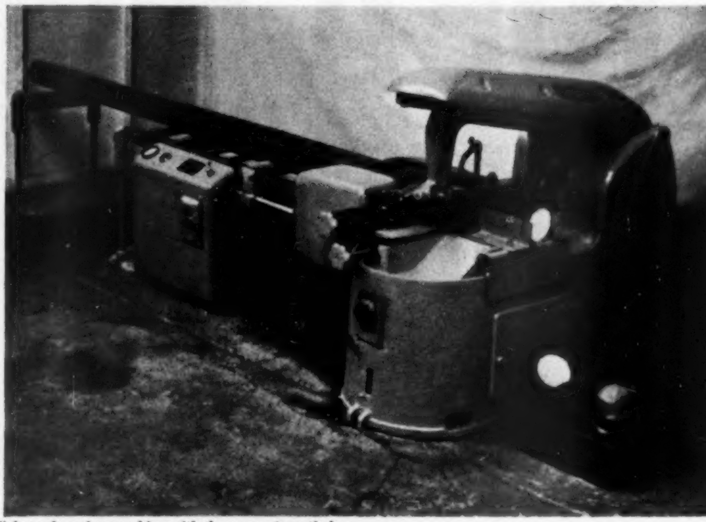
Hacksaw Automatic Bar Feed

Charles Wicksteed & Co. Limited, Kettering, have designed an auto-bar feed unit specially for their 8 in. 'Hydramatic' sawing machine. It provides high output cutting of varying types of metals up to 6 in. dia or 6 in. square. The unit is particularly robust and pneumatically operated. A compact self-contained air compressor and reservoir

unit is supplied where shop air is not available. A counter is provided by which the number of cuts required may easily be set and on completion the machine stops automatically. The system is fully interlocked and any failure of the air supply, vices or other components stops the machine. A further safety device is provided as an optional extra: this will prevent the machine continuing the cycle in the event of blade breakage, and is especially recommended for cutting long bars. One vice works on a travelling carriage, the other is fixed on the machine, giving a very strong clamping action.

A 230 volt a.c. electrical supply is internally transformed to 110 volts a.c., for the relay control of the bar feed mechanism. The sawing machine itself works on a 400/440 volt, 3 phase, 50 cycle supply.

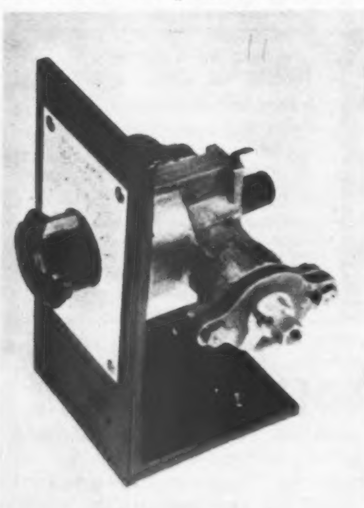
The minimum length of cut off is ⅛ in. and the maximum 18 in. A graduated setting bar is provided. The feed and clamping cycle is approximately 8 sec for the maximum length of 18 in. of bar travel and proportionally less for shorter lengths.



Wicksteed sawing machine with the new automatic bar feed

Pneumatic Controller

A pneumatic controller being made by Edward Pryor & Son Limited, Sheffield was originally invented for use on their marking machines; it is capable of application in many industries. The device is operated by air pressure signals derived from some suitable part of the machine to be controlled. At the end of a pre-set number of pulses, the device passes an output signal to some position of the machine which will effect a control, for example stopping the machine. The appliance can provide counts up to either ten or twelve, will respond to either pressure rise or pressure release, and will operate over a pressure range of 10 to 100 psi. The commencement of a new cycle can be arranged to be entirely automatic or dependent on an air signal from a manually operated valve. As the device is entirely pneumatic, containing no electrical apparatus, it is intrinsically safe where there are fire or explosion hazards.



Pryor pneumatic controller

Co-ordinate Inspection Machines

The new Mk II and Mk III co-ordinate inspection machines made by Ferranti Limited, Dalkieth, Midlothian, cater for increased work capacity and incorporate a number of design improvements. Basically the machine has a horizontal T-slotted work table with free access at front and sides on which the work to be inspected is placed. A cantilever arm projects over the worktable from the back and carries a probe mounted in a pre-loaded ball sleeve housed in a carrier bracket. Movements of the probe in the x and y directions are measured by diffraction gratings fitted to each slide, and immediately indicated by illuminated decade counter displays on the panel at the rear of the work-table. Measurements can be made to an accuracy of $\pm$ ·001 in. over a distance of 24 in.

Ferranti Mark II co-ordinate inspection machine

The cast iron table casting has been re-designed to eliminate the well at the rear, and the guide rail is now mounted at table level to give increased height. The Mk III machine uses a modified table with homogeneous 10 in. upstand. Other improvements include improved blower filtration system; improved bearings; symbolic representation on the display panel; removal of power supply unit to base casting and fitting of isolation switch facilities on the plug panel.

Additional devices include a work subplate for the reduction of set-up time on repetitive work, and a microscope attachment for inspection of fragile and flexible components such as rubber mouldings.

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technique

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Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Large Bushes Removed by Shrinking with Liquid Nitrogen

During the annual shutdown of Firth Vickers Stainless Steels Limited and while overhauling a Robertson 4 high cold rolling mill used on stainless steel from ¼ in. to 22 gauge (erected in 1936) it was decided to remove two large, internally threaded, phosphor bronze bushes. These bushes, pressed into cast iron housing, receive the adjusting screws for the top rollers used for determining the final thickness of the rolled metal. The bushes, 21 in. outside diameter by 21 in. depth and having an internal diameter of 14 in., are pressed into housings with 0·002 in. interference fit.

After trying various mechanical methods of extraction to no avail the use of liquid nitrogen to shrink the bushes and drop them out of the housings was decided upon. The first bush was prepared by placing a lead plate under it, making the bush into a cup. Liquid nitrogen was poured direct from a British Oxygen tanker into the cup. After five minutes, the bush started to move. After twenty minutes, the bush had dropped without any mechanical assistance into a receiving cradle placed ready. The second bush was treated in a similar manner and dropped into the receiving cradle only two minutes after commencing pouring the liquid nitrogen. The operation required 3,000 cu ft of liquid nitrogen.

Is the Know-all Foreman an Asset or a Liability?

I have yet to meet one who is a successful leader. They are invariably successful in rubbing people the wrong way. What more infuriating a creature than the person who is always blatantly right? He makes it so obvious, to the annoyance of those of us who are quite often wrong. Psychologically, to my mind, it is the wrong attitude for a responsible executive to give the cocksure impression of always being right. It tends to discourage others who eventually fight shy of offering suggestions. Many valuable hints and much intelligent service are thus lost to the company.

When men feel dwarfed and overshadowed they loose interest and cease to give of their best. The "Always Right" is a menace in the shops which, intelligently managed, should house a body of workers all giving of their best and vying with each other in an effort to excel. That is the ideal and given proper leadership it works—I have seen it in action. The foreman who can inspire and maintain such a shop atmosphere never pretends to know all the answers and his job gives him few headaches. The way he achieves that, the method he employs, is of secondary importance. If he can inspire happy eagerness in the shops by sometimes being wrong, what's wrong with that?

From experience, I'd say his chances of gaining and retaining the confidence of his men would be much greater were he occasionally wrong than always so abominably right. When a foreman can command the confidence and respect of his men in virtue of his skill and organizing competence, without continually flaunting that competence in the faces of his men, he has reached the ultimate in shop management. Before men can give respect there must be some common bond, some feeling of equality. The foreman who does not feel it beneath him to admit a mistake or a lapse, provides this fellow-feeling, this something-in-common which compels respect and sometimes engenders affection.

Unfortunately, some feel it beneath their dignity to consult with their men in moments of doubt. That is a narrow and mistaken view, a form of childish vanity. Such foremen must know that on being consulted by higher management, a compliment has been paid them. It is an indication of confidence in their knowledge and experience. I have known foremen boast of being so consulted yet ridicule any suggestion that they might profit by higher management's example and take suitable shop floor men into their confidence when occasion arises. It is illogical for a foreman to preen himself on being consulted by his chief, yet to regard it as *infra dig* for him to consult with his men. To make men feel they are one of a team, not merely cogs in a wheel, creates a sense of partnership. That is leadership at its best; a compliment is paid and compliments, genuine and deserved, are the cement which holds the industrial and social fabric together.

As a young assistant works manager I had a very capable chief foreman who knew all the answers and made a point of freely advertising the fact. He was thoroughly unpopular because of his know-all, faintly patronizing manner. Discussing him with an executive friend of ripe experience, I was advised to pretend to be rather dull. I acted on this advice and thereafter, If I had any new scheme in mind, I would jot down some elementary notes along with rough sketches and send for old Fred to talk things over. At our meeting I would explain what I had in mind, making a faint show of having evolved something rather new and good, the while I noted his smile of almost condescension.

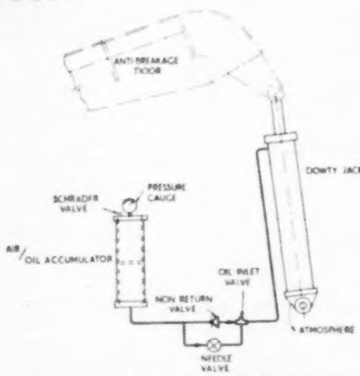
With assumed timidity, I would push my notes and sketches across to him and pleading pressure of work, would suggest he looked them over, adding "and in view of your wide experience, if you feel you can improve on this please don't hesitate". His smile would broaden, I could almost hear the old scoundrel purr. Sure enough, the following morning I would find on my desk, sheets and sketches all in his neat hand. The revised version down to the last comma. This became a habit with me, I can recommend the ruse, it saved me many hours of work and flattered old Fred's ego. I often wonder how many hours he spent working at home in order to show me how dumb I was. When I was leaving for pastures new I wandered down to his office and, as I murmured my thanks for all the help he'd given me I laid a case with two briars on his desk. My hand was instantly grasped in his ample paw and, blushing like a young girl, old Fred brushed past

me, muttering something about having to see to some nightshift work. I never saw him again but sometimes wonder how we would have parted had I entered into competition with him in the "know all" business. The executive who expects to get maximum co-operation from assistants on know-all lines has something to learn.

A sense of humour in a shop executive is a priceless possession and the foreman who lacks that is a dead loss to his employer. A really successful one with a keen sense of humour made a point of having a word or two with some of his men each day. Passing a machinist, a shop steward of many a friendly tussle, he noted the man was setting up an awkward job, the first of a batch. Looking over the man's shoulder, he said in leg-pulling fashion "that will be your third one, Bob." Bob raised his head from the job, looked the foreman square in the eye and replied with a sly smile "yes, that's my third one, boss, I'm doing it first". The boss laughed delightedly and said "congratulations, you've won, lad". The foreman concerned was a really strict disciplinarian with the right idea of how to put it across.—A. Scot.

Skip Anti-breakage Door

The control gear, incorporating an air/oil accumulator, for a skip anti-breakage door shown in the accompanying diagram, ensures that as the weight of coal loaded into the skip increases so does the resistance of the door increase, but only enough to have a steadying effect on the coal, thereby reducing to a minimum the risk of breakages. The action of coal loading forces oil from the piston end of the jack through the non-return valve and into the accumulator. After the coal is discharged the pressure built up inside the accumulator forces the door back to its original position. As the speed of return is controlled by the setting of the needle valve all shock loads are eliminated and no damage occurs.



Layout of mechanism for anti-breakage door

This control equipment was fitted eighteen months ago to skip doors at Langwith Colliery in the National Coal Board's East Midlands Division and in the light of its efficiency and reliability is to be used on all other skip doors in the Division's No. 1 Area. The inventors—Mr. W. H. Cindrey (Area Hydraulic Supervisor), Mr. C. Kerry (fitter, Whitwell Colliery) and Mr. J. A. Mitchell (shop foreman, Whitwell Colliery)—in the case of the Langwith skips pumped air into the accumulator up to 200 psi. Then oil was pumped into the circuit until the door was raised firmly up to the door stops. But a wide range of pressures and return speeds, they claim, can be obtained with this simple system. Features are the convenient placing of the air inflation valve, the oil inlet valve and the pressure gauge behind the existing inspection door at the front of the skip. The jack and the accumulator are easily housed behind the skip door without modifications and are afforded all the protection necessary.

Lathe Face Plate Repair

At the works of Head Wrightson & Co. Limited a lathe face plate with twelve ribs radiating from the centre piece had a crack develop in six of the ribs near the centre, consequently it was not possible for the component to maintain equilibrium during operation. At first the damage was thought to be so serious that a complete replacement was contemplated but after survey a method of repair was devised which combined the insertion of steel inserts together with welding.

Normal Metalock repair procedure was used to repair the six cracks. Then in order to lessen the strain on the centre of the plate it was decided to insert steel inserts between the ribs. A centre plate was made to fit over the centre boss and to the edge of this plate the twelve steel inserts were tack welded. Having thus made an assembly of centre piece and inserts the repair men lifted it off, turned it over and completely welded the assembly together, from the back. The assembly was then replaced in position over the face plate and Metalocked into position. Thus a large replacement cost was saved and the lathe was able to return to operation in a matter of days.

The Metalock method of repairing a casting fracture consists of peening into prepared apertures, at set centres, layers of Metalock keys. These keys are serrated strips of a ductile metal alloy, composed of nickel, steel and other elements. The apertures into which they are inserted are made at right angles to the fracture and are identical in shape and length to the keys. The depth of these apertures depends on the seriousness of the fracture and thickness of the parent metal. Several keys may be peened into a single aperture, dependent on the thickness. Since they are highly ductile, keys are peened into a metal-to-metal condition and become almost integral with the parent metal of the object under repair. The high tensile strength of the keys ensures a return of a high percentage, if not 100%, of the original lost strength.

The next stage is drilling holes along the line of the fracture, tapping them and screwing in studs. This operation is carried out progressively so each stud bites into the stud already inserted next to it. This is the Metalace method which is complementary to the system of keys already described.

The insertion of a line of these interlaced studs along the fracture is of major importance. They restore rigidity to the casting through their shear value along the line of fracture and also through the shear value of the threads through the depth of the parent metal.

The third feature of this repair method is Masterlock which is a block of high tensile steel, rectangular in shape. Its edges are serrated in the form of half-round holes. Like the Metalock key, it is inserted into a prepared aperture and, when in position, the surface is flush with that of the parent metal. Half holes in the parent metal match up with those in the Masterlock and the resulting full holes are filled with layers of short dowels, which are peened into position. The Masterlock is applied in areas of components where great stress is concentrated.

Materials Handling-3

Electric trucks are well known, but the various types and some of the advantages they give are not so widely appreciated. Electric trucks can travel around an area at a greater speed than a hand truck, can carry a greater load, and can stack it at any reasonable height. They also exert a psychological effect upon the worker. For example, the driver of a power truck is generally found to keep to his job more consistently than a manual trucker.

BATTERY ELECTRIC TRUCKS

Trucks should be considered where material has to be moved between a number of points which are not generally fixed. The flow of materials may be intermittent or irregular. The type of truck depends upon the work to be undertaken and whether stacking for storage purposes is to take place in conjunction with movement.

Trucks do not necessitate heavy buildings, but they do require good flooring.

The battery electric truck derives its power from a storage battery of its own. Traction batteries are better than ever and guaranteed for four years, though they often last much longer. Battery charging is advantageously carried out off-peak at night.

Unlike an engine with many moving parts, the electric motor has only two bearings, and maintenance is no problem. No other truck is so silent and completely fume free, and no dust is blown about by blasts of exhaust gases. Fire risk is reduced.

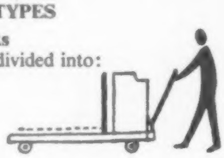
With some goods, risk of contamination from exhaust gases must be eliminated. Befouled air and air from which oxygen has been extracted by internal combustion engines is bad for personnel in all factories.

Trucks are used for lifting, moving and storing material.

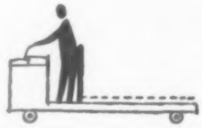
TRUCK TYPES

1. Pedestrian-controlled Trucks

These may be further sub-divided into:
- (*a*) Platform
- (*b*) Pallet
- (*c*) Fork Lift



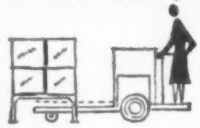
2. Rider-controlled Trucks
- (*a*) Platform
- (*b*) Pallet
- (*c*) Fork Lift
  - (i) counterbalanced type
  - (ii) outrigger type
- (*d*) Tractors
- (*e*) Side Loaders
- (*f*) Road Type



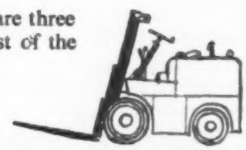
3. A wide variety of truck attachments and accessories is available.

Platform Trucks—On these vehicles the materials must be loaded by hand or mechanical means. Both pedestrian- and rider-controlled trucks are made to lift several tons. Platforms are fixed or elevating. Elevating platforms enable a pre-loaded work carrier to be picked up and deposited without waiting-time.

Pallet Trucks—These vehicles necessitate the use of a pallet on which the stacked materials are mounted, and on which they are conveyed by the truck to their destination. They are used for moving a palleted load of up to 6,500 lb. Good floors are essential for their small-wheels.



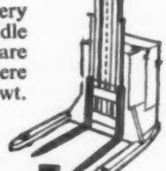
Fork-lift Trucks—There are three basic types. They consist of the following:
- (*a*) Counterbalanced
- (*b*) Outrigger
- (*c*) Reach

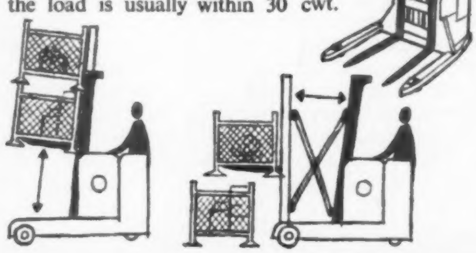


These well-known vehicles incorporate two horizontal steel arms which slide beneath the load, lift it sufficiently to clear obstructions and convey it to its destination. The next Data Sheet gives further details of this invaluable aid to materials handling.

Counterbalanced types are vehicles which are provided with load-carrying forks operating in front of the front wheels. The comparatively heavy truck and its associated battery provide the necessary counterbalance for the forward-placed load.

Outrigger or Straddle types are very compact. The front wheels straddle or pass outside the load. They are especially useful in warehouses where the load is usually within 30 cwt.



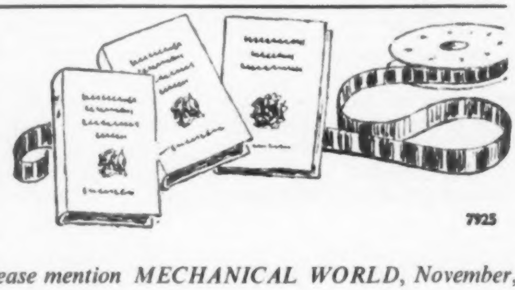


Reach types are rider controlled. The fork carriage is movable in a horizontal plane, with forks reaching beyond the front wheels to withdraw the load to a position within the wheelbase; virtually a combination of the counterbalanced and outrigger types.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books are available on electricity and productivity (8/6 each, or 9/- post free)—'Materials Handling in Industry' is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity including one on materials handling. Ask for a catalogue.



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In Brief . . . .

Notes on New Materials, Plant and Machinery

Australian Pumps.—Mather & Platt Limited, Manchester, are to market in Britain a range of centrifugal pumps made by their Australian subsidiary, Kelly & Lewis Pty. Limited. They will be known as the KL 50 range.

Plant Boiler.—The new plant making town gas solely from low grade petroleum at the Cremorne Works of the Eastern Gas Board at Norwich, uses steam from a town gas fired Steambloc packaged boiler supplied by Spencer-Bonecourt-Clarkson Limited, London.

Electrolube Grease.—The electrical lubricant made by Electrolube Limited, Slough, is now available in the form of grease in handy pocket-sized capsules.

Rotary Hearth Furnace.—An electrically-heated rotary hearth furnace for the economic heating of rough and fully machined steel components has been supplied by Metalectric Furnaces Limited, Smethwick for the Glasgow plant of The Caterpillar Tractor Company Limited.

Steam-Raising Boiler.—The new Sampson-Albion vertical multi-tubular, oil-fired, steam-raising boiler designed and manufactured by Sermac Limited, Richmond, Surrey, is reasonably priced, of medium capacity and of low installation and operating cost.

Water Treatment.—Kinnis & Brown Limited have installed an Aqua-Clear feeder at Colvilles Limited, Motherwell.

O-ring adaptors.—An extensive new range of SAE 'O' ring adjustable adaptors for incorporation into all hydraulic circuits has been designed and manufactured to American SAE standards by Oil Feed Engineering Company Limited, London SE1.

Motor Starters.—Dewhurst & Partner Limited, Hounslow have introduced two new ranges of squirrel cage motor starters, direct-on-line up to 60 hp, and star/delta up to 45 hp both at 400 V.

Electric Cable Lugs.—New to the range of overhead line equipment made by Bowthorpe Electric Company Limited, Crawley, are Utilux cable lugs manufactured from copper alloy and of the bolted type.

Terminating Tool.—British Insulated Callender's Cables Limited, London, has developed the "Rotocrimp" tool for crimping the mouth of the brass sealing pot after filling with moisture-resisting compound, to retain the sealing disc inside the mouth.

Industrial Tools.—Black & Decker Limited, Harmondsworth, have produced two new tools, the ¼ in. 'Shorty' drill, price £28 and the No. 8 gauge nibbler, price £160.

Loading Crane.—The Steinbock loading crane type LK2 supplied by G. Hunter (London) Limited which can load lorries and railway trucks quickly is mounted on a lorry and has a telescopic jib.

Cable Sleeves and Markers.—The Cable Accessories Division of Hellermann Limited, Crawley, announces a new range of sleeves and cable markers designed for fitting without the aid of tools.

Lighting Controller.—A really low cost lighting controller to supplement their more expensive range has been introduced by Elcontrol Limited, Hitchin.

Ventilated Garment.—A ventilated garment for use in steelworks crane cabs and other hot surroundings has been developed by the department of operational research of The United Steel Companies Limited, in co-operation with the work study department of Steel, Peech and Tozer.

Engine Indicator Equipment.—C.A.V. Limited, Acton, have a new range of special transducers resistive (for pressure) and inductive (for displacement), primarily for precise measurement and engine operating variables.

Butters Derrick.—Butters Bros. Limited have a 10-ton derrick of their new design erected at their London works where it is available for inspection and examination.

Hard Facing.—A new series of hard facing alloys has been introduced by the Eutectic Welding Alloys Company, Feltham.

Portable Drive.—A handy industrial flexible shaft machine which can be carried in one hand with a ¾ hp motor is made by Burflex Limited, Brierley Hill.

Rectifier Drive.—A new low cost adjustable speed drive utilizing the silicon controlled rectifier in a fully transistorized arrangement has been developed by Lancashire Dynamo Electronic Products Limited, Rugeley, to provide variable speed for industrial application.

Dipping and Pickling.—The new bright dipping and pickling unit of F. W. Berk & Co. Limited, London, NW10, is a self-contained unit of advanced design for the cleaning of metal and alloys by surface treatment with acids.

Oil Can.—The Reilang oil can marketed by The Wymark Company, Little Comberton, works in any position, delivers a pre-set quantity and is leak proof.

Mechanical Seals.—Chemical Equipment Engineering Limited, Macclesfield, are supplying a range of agitators fitted with a specially developed cartridge mechanical seal assembly in place of the conventional stuffing box.

Voltmeter.—The new Blackburn Electronics Limited, Brough, five-digit voltmeter and ratiometer has an accuracy of $\pm(0{\cdot}005\% + 1$ digit) of full scale.

Welding Control.—A new 'packaged' resistance welding control is now available from Lancashire Dynamo Electronic Products Limited, Rugeley.

Separators.—A newly designed range of moisture separators and moisture separator assemblies has been introduced by B.E.N. Patents Limited, High Wycombe.

Instrument Casings.—Instrument casings for their range of temperature, pressure and vacuum chart recorders have been re-designed by the British Rototherm Company Limited, Merton Abbey, London SW19, to provide a slimmer, more compact unit.

Two-speed Drills.—Three new double-insulated two-speed drills covering a wide capacity range are announced by Black & Decker Limited, Harmondsworth. They are for $\frac{5}{16}$ in., No. 1 Morse taper $^{35}/_{64}$ in. and No. 3 Morse taper 1¼ in.

Automatic Forging Roll.—The third of a new series of automatic forging rolls has been manufactured recently by Lamberton & Co. Limited, Coatbridge. It produces forgings with several differing diameters in their length automatically with consistently accurate dimensions and a surface finish suitable for many uses without machining.

Industrial Drills.—The 77-Series Neonic electric drills manufactured by Stanley-Bridges Limited, London SW1, is now available with a pistol grip additional to the centre and saw types.

books

Industrial and Marine Gearing. By S. A. Couling. London, 1962; Chapman & Hall Limited 45/- net (by post 46/1). 236 pp. $5\frac{1}{2} \times 8\frac{1}{2}$ in.

This complete text on the design and manufacture of heavy gearing, particularly helical gears, is one of the series of texts sponsored by A.E.I. The author is a foremost authority with a lifetime of experience in the subject, who pioneered the technique of the fine pitch indexing worm drive and was responsible for the first high power, high ratio, locked-train double reduction gear produced for the Admiralty. In the book he begins with an explanation of basic gearing design and the geometry of gear teeth and goes on to describe the two main categories of marine gear drives and industrial gears and gearboxes, after which he discusses the materials used in the manufacture of gears and their relative costs. From there onwards the text deals with manufacture, first with gear cutting machines and tools, then checking, testing and research, and finally the hobbing process and the effects of hob form on involute helical gear tooth profile.

Thin-walled Elastic Beams. By the late V. Z. Vlasov. Translated from the Russian by Y. Schechtman. Jerusalem, 1962. Program for Scientific Translations. 95/- net (by post 97/3). 493 pp. $6\frac{3}{4} \times 9\frac{1}{2}$ in.

The "thin-walled" beam is recognisable in many constructions and particularly in ships and aircraft. A thin-walled beam which has in its unloaded condition the shape of a cylindrical shell or prismatic hipped section is considered in Vlasov's theory as a continuous spatial system composed of plates capable of bearing moments as well as axial stresses. The author develops a "law of sectorial areas" from general assumptions of inflexible section contour and absence of shear in the middle surface, which permits of stress calculation in the most general cases of flexural-torsional equilibrium. The book also presents results of experiments designed to check the validity of the theory.

The book opens with an explanation of the theory of thin-walled beam shells of open cross section and goes on to their calculation, after which transverse connexions are introduced and also closed sections. Next, spatial stability is considered for various conditions and the general theory introduced after which attention is given to beams of solid section, the bi-moment theory of thermal stress, and plane and tortuous thin-walled curved beams.

Lubrication and Friction.—By Peter Freeman. London, 1962; Sir Isaac Pitman & Sons Limited. 17/6 net (by post 18/1). 182 pp. $4\frac{3}{4} \times 7\frac{1}{4}$ in.

This is a compact, rather small book, and to have in it such a basically complete and competent treatment of the highly specialized subject of lubrication will make it readily welcome to engineers concerned in any way with machinery, whether as regards design, manufacture or use. Petroleum-based lubricants are shown for what they are, and then the lubricating properties explained. From this the author goes on to lubrication theory and then to the special circumstances of the principal applications—the phenomena encountered in bearings, etc. As the title indicates, the subject of friction (of metals) is also dealt with, and there are chapters also on solid lubricants, cutting fluids, and rolling contact bearings.

Civil Engineering Plant Handbook. by Rolt Hammond. Edinburgh, Oliver & Boyd Limited. 50/- net (by post 51/6). 277 pp. $7\frac{1}{4} \times 9\frac{3}{4}$ in.

"The modern contractor's plant depot is a mechanical engineering works planned on a flow basis." This quotation from Mr. Hammond's preface, though incidental to his book, does suggest why such an extensive collection of specification data is necessary, since the original dimensions, performance data and the like, of which the text is composed, will constantly be required in order to keep plant up to pitch. The particulars of the different machines are given under makers' names, and collected into categories comprising excavating plant, compressed air equipment, rock drills, pumping plant, hydraulic equipment, oil engines, tractors, piling plant, crushing plant, concrete plant, mechanical handling plant, mixing plants, railway equipment, road transport equipment, cranes, and welding equipment.

Heat Bibliography, 1961. Edinburgh, 1962; H.M. Stationery Office. 25/- net (by post 27/3). 325 pp. $8 \times 11\frac{3}{4}$ in.

A constant survey is made at the National Engineering Laboratory of the world's literature in the heat transfer and applied thermodynamics field. Titles of interest are noted and each year the collection is published as the Heat Bibliography. The latest edition is that for 1961 and contains references to heat engines and power plant; atomic energy; heat exchangers, boilers and condensers, and chemical and physical properties of technically important substances.

Vibration Analysis and Design of Foundations for Machines and Turbines. By Alexander Major. Translated from the Hungarian and German by A. Frankovszky, Z. Szilvassy and J. Toth. London, 1962; Collet's Holdings Limited. £5-5-0 net (by post £5-7-9). 828 pp. $6\frac{1}{2} \times 9\frac{3}{8}$ in.

Dr. Major takes the provision of foundations for rotating machinery out of the mist of empiricism and places it firmly on a scientific basis. He has had plenty of opportunity for testing his ideas in practice, having been responsible for important foundation work in several countries and in greatly varying conditions. His treatise is a large volume which is divided into seven parts and 23 chapters. He deals fully with vibration and foundation theory, soil investigation (this in its widest sense), structural design and analysis, vibration damping, vibration in buildings, bridges and vehicles, and the dynamics of hydraulic structures. The treatment throughout is realistic in its relation to practice, and the concluding section (No. 7) presents 14 numerical examples, most of them concerning actual foundations.

The Surface Treatment of Steel. By Eric N. Simons. London, 1962; Sir Isaac Pitman Limited. 35/- net (by post 35/9). 234 pp. $5\frac{1}{2} \times 8\frac{1}{2}$ in.

Mr. Simons is well known as author or co-author of a series of

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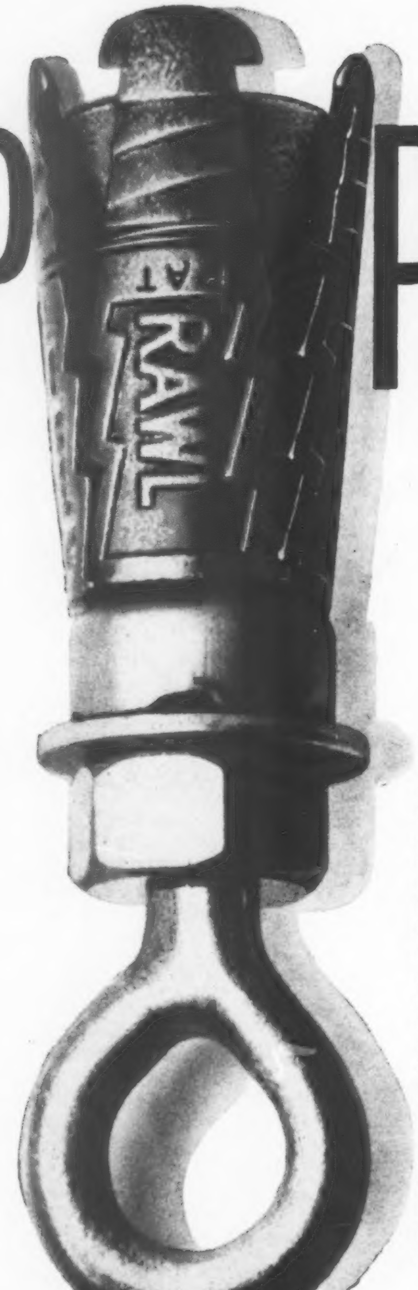
GRIPPING

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books on steel and kindred subjects, and certain aspects of surface treatment have already been treated in some of his previous works. The present volume deals with the remaining methods, and, like the previous volumes, presents the essentials in straightforward, readily comprehensible form. The various methods of cleaning are first surveyed (solutions and vapour, acid, salt bath, blast, shot, tumbling, barrelling) and then phosphating, colouring, metallic impregnation, metal spraying, lacquering, enamelling, etching etc.

Steam Trapping and Condensate Removal. E.E.U.A. Handbook No. 8. London, 1962; Constable & Co. Limited. 30/- net (by post 30/10). 96 pp. 6 × 9¾ in.

The principal objects of the Engineering Equipment Users' Association are to promote a common policy for the standardization of engineering materials, equipment and stores through the B.S.I. or otherwise, and generally to foster national standards for such products. This handbook was prepared by a panel of experts from member companies and has been issued publicly because of the general interest of the subject to industry. It explains methods for the assessment of condensate flow rates and pressure differentials, gives the text of the Code of Practice for Steam Trapping, discusses special cases of condensate removal, and gives recommendations on condensate receivers, vacuum return line systems, and air venting.

Current Researches in Machine Tools.—A DSIR committee, set up in 1960, to co-ordinate British research in machine tool technology, has published a comprehensive list of researches in this field. It lists the work of seven participating laboratories and gives brief statements of what is being done on machine tool performance, metrology, mechanisms, slideways, materials, machining and cutting, dynamic behaviour, vibration, error correction, dynamometer development and calibration, metal forming, etc. The booklet (No. 1 in a series) is issued from the office of the Machine Tools Co-ordinating Committee, State House, High Holborn, London WC1.

"The Fabulous Hill".—Seventy-seven years ago a great mining field was discovered in Australia, a discovery which transformed the country from a pastoral community into an industrial nation. The peculiar contour called "Broken Hill" contains the apparently inexhaustible resources of the richest ore body of its kind in the world. Its story is told in an almost fabulous publication in colour entitled "The Fabulous Hill", giving something of its romantic background and present world-wide significance. The book comes to us from Austral Development Limited, 95 Gresham Street, London EC2, and is possibly not generally available. If any reader wishes to see it they are welcome to borrow our copy.

Automation Pioneer.—The automation now existing, as well as future developments still in the laboratories, were clearly foreseen and explained in the 1920's by H. Stafford Hatfield, of London. Dr. Hatfield, who is still actively engaged in scientific work, was able to interpret with outstanding thoroughness and accuracy the significance and potentialities of the primitive electrotechnology that appeared after World War I. However, Dr. Hatfield is not generally recognized, in either the U.S.A. or U.K., as the forerunner of modern-day automation. To correct this oversight is the task assumed by the Amber brothers, who admit to being great admirers of Dr. Hatfield. The brothers are authors of a text and reference book, "Anatomy of Automation," 1962 (Prentice-Hall Inc., Englewood Cliffs, New Jersey. (256 pp. $10.60 net).

Hot Dip Galvanizing.—The edited proceedings of the Sixth International Conference on Hot Dip Galvanizing held at Interlaken, Switzerland, last year have been published. at £3 15 0 by the Zinc Development Association 34 Berkeley Square, London, W1. The volume consists of 410 pages, is fully illustrated and contains the text of the twenty-six papers together with discussions.

Aluminium Castings.—The information bulletin of this title published by The Aluminium Development Association, 33, Grosvenor Street, London, W1. has been completely revised and expanded. The emphasis is on the provision of information for the user of aluminium castings in order that he may derive the maximum benefit from the advice and services of the founder. Following a survey of aluminium foundry practice the choice of casting process is discussed and then various notes on design are given followed by notes on inspection and testing and the various finishes applicable to castings.

Training Courses Handbook.—The 'Courses Handbook', 20 pages, for the Training Courses for the Certificate in Works Management and the Diploma in Works Management has been published by the Institution of Works Managers, 196, Shaftesbury Avenue, London WC2, and may be obtained from them, price 1/- post free. The course is in four main sections, Fundamentals of Management, Management Law and the Economics of Industry, Works Management in Practice and Human Relations and Communication.

CoID Report.—In its 17th Annual Report the Council of Industrial Design 28, Haymarket, London SW1. stands up to critics who complain that it concentrates on encouraging modern designs to the exclusion of commercially successful traditional patterns. It points out that its task is a longer term activity than immediate trade promotion. Many people automatically associate 'modern' with Scandinavia, Germany or Italy. The CoID is combating this by demonstrating that good modern British design can stand comparison with its foreign competition.

New Standard

Cylinder Liners (B.S. 3525 and B.S. 3526). Price 10/- each.

The first of these standards specifies internal and external diameters and tolerances for dry type, unflanged, interference fit cylinder liners which, when finished machined in cast iron cylinder blocks of 4-stroke cycle single acting spark and compression ignition fluid cooled internal combustion engines (excluding aircraft engines) of 1-12 in. nominal bore, has bores of the dimensions specified in B.S. 3386 "Cylinder bore sizes for internal combustion engines".

The second standard, which applies to the same type of engine, specifies diameters and other detailed dimensions of two kinds of wet type cylinder liners from 2 in. to 12 in. bore designated 'X' and 'Y' types, and an additional type of wet type cylinder liners from 2 in. to 6 in. bore designated 'Z' type.

Both standards include recommended dimensions for the bores in cylinder blocks to receive these liners.

British Standards Institution, 2 Park Street, London W1.

BUSINESS & PROFESSIONAL

Personal

Mr. F. H. Needham, B.Sc., A.C.G.I., M.I.Struct.E., A.M.I.C.E., has been appointed head of BISRA's Civil Engineering Section, at Battersea.

Dr. A. W. Crook, F.Inst.P., has been appointed assistant chief engineer (Mechanical), Mechanical Experimental Development Department, in the AEI Turbine-Generator Division. **Mr. D. G. Smith, B.Sc.(Eng.), A.M.I.E.E.,** manager Small Industrial Machines Engineering Department, AEI Birmingham Works, retired on September 18 1962, after forty-six years service with the company. **Mr. W. A. Ciclitira, B.Eng., A.M.I.E.E.,** has been appointed manager, Commercial services, AEI (Manchester) Ltd. **Mr. I. C. Fitch, A.M.I.Mech.E., M.Inst.W.,** has been appointed assistant chief engineer of the AEI Heating Department, Trafford Park, Manchester. **Mr. J. L. Russell** has been appointed managing director and **Mr. L. S. Tredgett,** commercial manager, of the newly formed AEI Automation Limited.

Mr. Leonard H. Short, director of overseas operations of The English Electric Company Limited, has been elected chairman of the board of The English Electric Export & Trading Company Limited. **Mr. E. J. Sims** has been appointed manager, sales and contracts of The English Electric Company's Fusegear Division at Liverpool.

The British Materials Handling Division of Yale & Towne, Wednesfield, Staffs., announce the appointment of **Dr. R. J. Tonks, B.Sc., A.M.I.Mech.E., D.I.C.,** as chief research and development engineer.

The Benjamin Electric Limited announce the appointment of **Mr. A. A. Malden, B.Sc.(Econ).,** as assistant to the managing director.

Delapena and Son Limited announce the appointment of three new directors. They are **Mr. L. F. Frost,** chief executive, Induction Heating Division; **Mr. J. Threadingham,** chief executive, Honing Division, and **Mr. D. G. Jones,** chief development engineer.

Mr. H. F. Crane has been appointed general manager of Devcon Limited, 54, Furze Platt Road, Maidenhead, Berkshire.

Mr. A. V. Green, for the past 15 years Leeds area manager for Richard Lloyd Limited has now been appointed general sales manager and is stationed at the head office, Elmfield Avenue, Birmingham, 24. **Mr. R. Desmond** has been appointed Leeds area manager.

Mr. F. May, local director and secretary of Samuel Osborn & Co. Limited, retired on September 30 1962, having completed 47 years' service with the company. Mr. May is succeeded in the office of secretary by **Mr. I. G. Buchan, C.A.,** a director of the company. **Mr. F. Perks,** works manager of Osborn Foundry & Engineering Company, Limited has been appointed a director of the company. **Mr. J. Burgoyne. A.C.A., A.C.W.A.,** accountant of Samuel Osborn & Co. Limited, has been appointed a local director of the company on 1st October 1962.

Addresses

Associated Electrical Industries Limited announce that their main sales office in Sheffield is now at 19 Cumberland Street (Telephone Number 20051) (hitherto known as Magnet House). The AEI Lamp & Lighting company's office is at 145/147 Carlisle Street, and AEI-Birlec Limited continues to be at 11 Westbourne Road. AEI offices and stores at other Sheffield addresses have now been closed. The activities of the Heavy Plant Division, at present carried out at both Rugby and Trafford Park, Manchester, are to be concentrated at Rugby, and plans have been prepared to effect the transfer from Trafford Park during the next two years.

A new Ferodo depot, serving London and Home Counties north of the Thames, has been opened at 38 Willoughby Lane, Tottenham, N.17, and replaces the old depot at 10/12 Handel Street, W.C.1.

Singlehurst Engineering Limited have opened a depot in the Manchester area at 133 Greengate, Salford 3. The telephone number is Blackfriars 2737. The area was formerly supplied with hose and couplings from the company's headquarters at 72-76 Clun Street, Sheffield 4. Mr. G. Alan Raw has been appointed manager of the new depot. He will be assisted by Mr. W. Lane.

The British Industrial Measuring & Control Apparatus Manufacturers' Association has moved its headquarters to 11, Argyll Street, London, W1. Commander M.W.B. Craig Waller R.N. (retd.) has joined the staff. The telephone number is REGent 0568.

The Manchester branch offices and warehouses of A. P. Warren Limited, and Apwar Limited, have been transferred from Old Trafford to larger premises at Apwar Works, Mosley Road, Trafford Park, Manchester 17. Telephone numbers unchanged.

The Middlesbrough branch office of General Refractories Limited Sheffield, parent company of the Genefax Group of manufacturers of refractory and heat insulating materials, has moved to new premises at Yorkshire Bank Chambers, Wilson Street, Middlesbrough. Mr. R. Marshallsay, area sales manager and Mr. J. N. Place, representative. The telephone number remains as M'BRO. 2392.

The Package Sealing group of companies of Ealing, London, are to move their head office and all facilities to Maidenhead, Berks, early in November. The new address will be: Pakseal House, Cordwallis Estate, Maidenhead, Berks. Telephone: Maidenhead 26381/7

The telephone number of British Ermeto Corporation Limited, Hargrave Road, Maidenhead Berks, is now Maidenhead 23423. Telex number unaltered.

John Hill & Sons (Iron Founders) Limited, a member of the Staveley group of companies, have transferred their machine shop to larger premises in Lever Street, Wolverhampton. (Telephone Nos. 24981 and 23445).

Contracts and Work in Progress

Associated Electrical Industries Limited.—Order from the British Transport Commission for a further 165 sets of power equipment for diesel-electric locomotives worth approximately £6,900,000.

Contracts for mine-winding equipment totalling £460,500 in value have been secured by the Heavy Plant Division. Two of these are for South Africa and the third is for the National Coal Board.

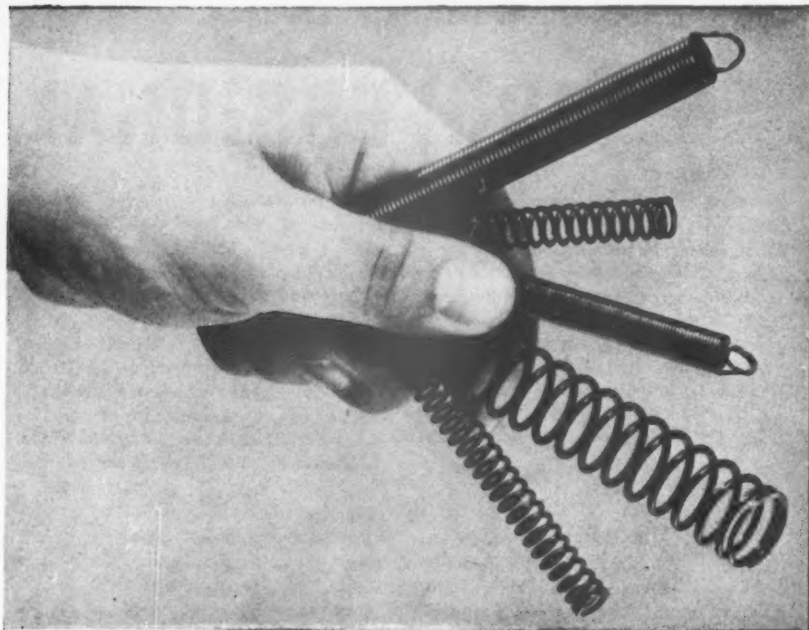
Order from the Goss-Meihle-Dexter Company Limited through Electrical Drive Applications Limited for a newspaper press drive, to be installed at the Northcliffe House, London, premises of *The Daily Mail* and *The Evening News*.

Imperial Chemical Industries Limited.—Hydrocarbon reforming plant for the £1m. contract awarded by the Southern Gas Board to Humphreys and Glasgow Limited.

David Brown Industries Machine Tool Division, Trafford Park.—Order worth £70,000 from Machinoimport, the official purchasing organisation for machine tools in Bulgaria, has been placed for gear hobbing machines.

Sir William Arrol & Company Limited.—Contract value £74,320 for building and installing the machinery for the Manchester University Mark II Radio Telescope to be erected at Jodrell Bank awarded by Ministry of Public Building and Works.

The British Hoist and Crane Company Limited, Compton, Berks.—Order from

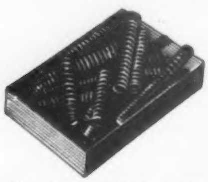


Let Terry's assorted springs help with your experiments

No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **15/-**

No. 757. Extra Light Compression, 1 gross Assorted, $\frac{1}{8}$" to $\frac{7}{16}$" diam., $\frac{1}{4}$" to $2\frac{1}{4}$" long, 27 to 19 S.W.G. **18/-**

No. 753. Three dozen Assorted Light Expansion $\frac{1}{4}$" to $\frac{1}{2}$" diam., 2" to 6" long, 22 to 18 S.W.G. **12/-**



No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G., $\frac{1}{4}$" to $\frac{1}{2}$" diam. **7/6**

No. 1217. One gross Assorted springs. **45/-**

No. 758. Fine Expansion Springs. 1 gross Assorted $\frac{1}{8}$" to $\frac{1}{4}$" diam., $\frac{1}{4}$" to 2" long, 27 to 20 S.W.G. **18/-**

Pick the spring you want, when you want it, from our fine range of small Boxed Assortments of Experimental Springs. We can show you only a few from the range here. Send a postcard for our full list—and if ever you're stuck with a Spring problem our Research Department will be pleased to put their long experience at your disposal.

HAVE YOU A PRESSWORK PROBLEM?

If so, the help of our Design Staff is yours for the asking.

TERRY'S *for SPRINGS*

Really interested in Springs? "Spring Design and Calculations", 11th Edition tells all—post free **12/6**

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You'll need Tool Clips. Hardened and Tempered. Sizes from $\frac{1}{4}$" to 2"

Cut Production Costs with Terry's Wire CIRCLIPS. We can supply immediately from stock—from $\frac{1}{8}$" to $\frac{3}{8}$".

HERBERT TERRY & SONS LTD

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(Makers of Quality Springs, Wireforms and Presswork for over 100 years)

All prices quoted subject to trade discount.

the War Office Contracts Department to supply 20 Iron Fairy 3-60 fast mobile cranes for the R.A.F.

THE FRASER AND CHALMERS Engineering Works of The General Electric Company Limited. Order for large double-roll crusher to be used in a lead-zinc sinter plant in Rumania received through Huntington Heberlein & Co. Limited.

G. & J. WEIR.—Contract for feed water treatment plant at the BP Grangemouth refinery in Sirlingshire.

F. & D. M. HEWITT LIMITED.—Contract for mould-making shop for Ranelah Steel Moulds, Limited, New Road, Newhaven, Sussex.

S. H. HEYWOOD & COMPANY LIMITED, crane makers, Reddish, Stockport.—Contract from Stewarts & Lloyds, Limited, valued approximately £120,000 for nine 6 ton overhead electric travelling cranes of 85 ft. span.

WILD BARFIELD LIMITED (Parkinson Cowan Group) Induction heating generator for Nyasaland Railways Limited, for tool tipping in the locomotive workshop at Limbe.

WILD BARFIELD LIMITED—Order for mesh belt conveyor furnace and endothermic atmosphere plant and a vertical forced air circulation furnace from Wellworthy Limited of Lymington, Hants., on behalf of their associates India Pistons Limited of Madras.

METAL INDUSTRIES.—Steelwork controls valued at £90,000 are being supplied to the Jamshedpur (India) works of the Tata Iron & Steel Company, and to their English companies.

Business Developments

Agents and Distributors

ASSOCIATED BRITISH MACHINE TOOL Makers Limited, following an agreement with J. L. Jameson Limited, Ewell and Chessington, Surrey, will market their special purpose machine tools.

EDDISON PLANT LIMITED have been appointed distributors for the full range of hoists and mobile cranes manufactured by The British Hoist & Crane Co. Limited.

GRATON & KNIGHT LIMITED, Boreham Wood, Hertfordshire, have been appointed sole factory agents in the United Kingdom by the Lewellen Manufacturing Company, Indiana, U.S.A., for their range of variable speed apparatus.

GIRDLESTONE PUMPS LIMITED, Woodbridge, Suffolk, have recently appointed the Kumait Company of Baghdad as their agents in Iraq. The agents' address is P.O. Box No. 130, Baghdad, Iraq.

BURFLEX LIMITED, Brierley Hill, Staffs., have been appointed agents in the counties of Warwickshire and Staffordshire, for Progrega Limited process for the elimination of friction.

Trading Agreements

CONSTRUCTION MACHINERY LIMITED which manufactures Wakefield motor graders and exports to 62 different countries, is to be integrated with British Jeffrey-Diamond Limited. British Jeffrey-Diamond Limited will take over the marketing of Wakefield motor graders through its Construction Equipment Division and the trade name, Wakefield, will now be used for all non-mining products.

MARTONAIR LIMITED, pneumatic engineers of Parkshot, Richmond, Surrey, have formed a new company, Martonair (Australia) Pty. Limited in association with their Australian agents, McKinnon Nicholls Pty. Limited.

BRUSH ELECTRICAL ENGINEERING COMPANY Limited, a member of the Hawker Siddeley Group Limited, and the General Electric Company Limited have reached agreement for the respective traction divisions to collaborate fully in all aspects of rail traction business.

HIGH PRECISION EQUIPMENT LIMITED, Bletchley, Bucks, have recently concluded a license agreement with Baird Machine Company, Stratford, Connecticut, U.S.A., for the manufacture in England of "Baird" 76 H and 78 H multi-spindle chucking machines, and their distribution throughout the British Commonwealth, South Africa, Sweden, Norway, Denmark, Switzerland, Austria and Portugal.

ARRANGEMENTS have recently been concluded to enable W. G. Pye & Co. Limited to manufacture, in England, pH Electrodes to the specification of Dr. Werner Ingold of Zurich, Switzerland.

Company Acquisitions

CASTROL LIMITED have acquired 75% of the issued share capital of McAlpine Chemical Company Limited.

CHLORIDE ELECTRICAL STORAGE COMPANY Limited have aquired the major assets of AEI Secondary Battery Department. AEI is to discontinue the manufacture of electric storage batteries.

150th Anniversary

IN the year 1812 a young man, John Hall, established a small iron, copper and tin plate merchanting business known as Higgins Yates & Hall. The name was changed to Hall & Pickles some six years later when the business was transferred to Manchester. In 1901, the first branch office was opened in London and a year later land was purchased in Trafford Park. The company continued its expansion and acquired other interests. The chairman of the holding company is Mr. P. C. Hall, a great grandson of the founder. Another great grandson, Mr. E. N. Hall, is chairman of Hall & Pickles. Between them the firms in the group employ about 4,500 people in the United Kingdom.

Trust to Aid Workers

A trust is to be set up in the United Kingdom by U.S. Industries Inc. (Great Britain) Limited to retrain workers in automation techniques and to counter personal and social problems created by the growth of automation here. Funds for the trust will be provided by a levy on each automation machine produced in the United Kingdom by the company. A similar trust has already been set up in the United States under the joint sponsorship of U.S. Industries and the International Association of Machinists, the trades union most directly concerned. The British trust will be run on similar lines and with similar objectives. An approach is being made to the T.U.C. to enlist their co-operation in the scheme.

Rockwell Exhibition

THE exhibition of Thiel toolroom machines now being held by Rockwell Machine Tool Company Limited at their Birmingham showroom will end on Friday, November 9 at 5-30 p.m. The exhibition and demonstration of Thiel machines is at 1-5 Cateswell Road, Hall Green, Birmingham 28, and is open from 9 a.m. to 5-30 p.m.

Film News

Trackless Tunnelling with Model 622 Loaders. This 16 min film, made by Eimco (Great Britain) Limited, Gateshead, shows Eimco Model 622 crawler mounted loaders in use for tunnelling, mining and shaft sinking at six locations in Great Britain. It is available on loan on application to Eimco (Great Britain) Limited, Earlsway, Team Valley, Gateshead 11.

USSR and Foreign Trade

A new foreign trade organization *Litsenzintorg*, has been set up in the U.S.S.R. to sell abroad patents on Soviet inventions and licences for their use. It will also purchase patents on foreign inventions.

Long Service Awards

IN September the Sheffield firm of Samuel Osborn & Co. Limited, presented certificates and gifts to a number of employees each with 50 or more years' service. The group was headed by the chairman and managing director, Mr. F. A. Hurst, who has 65 years with the company, and included 17 other men all of whom have achieved 50 or more years' service this year and two women each with 45 years' service. Recently the company announced a scheme of awards for employees who have completed at least 25 years' service. Presentations have been made to 540 employees and one in six of all employees qualified for awards.

Union Carbide SURVEY

UNION CARBIDE LIMITED FLAME PLATING DEPT
MILLERS ROAD WARWICK Tel: WARWICK 41766
HEAD OFFICE: 8 GRAFTON STREET LONDON W1

Flame Plating increased drill life over six times

Recently a busy South Coast precision machine tool company operating in a highly competitive market was faced with the problem of rapid drill wear when drilling $\frac{1}{16}$" holes x $\frac{3}{4}$" deep in EN1A steel for drill chuck bodies, that they were manufacturing on a high production basis.

The original performance with normal high speed drills averaged 5,000 holes per regrind which amounted to a serious bottleneck in their planned batch production schedule. As the size of a batch may be anything from 20 to 30,000 units, this used to mean a shut down for drill grinding and tool setting as often as five times in the course of a batch. The Company decided to have their drills Flame Plated and the results have been nothing short of fantastic. They now run right through the longest batch without attention. Flame Plating in fact has increased the life of the drills certainly six times. What the ultimate life of the Flame Plated drills may be it is not possible to say, since they still do not need regrinding at the end of the batch. Needless to say, the Company is more than satisfied with the big savings in set-up time and drill replacements and with the greater speed and lower cost of production.

Wide Application

Other recently reported applications of Flame Plated metal cutting tools include spotfacing and milling cutters. In the rubber, jute and asbestos industries, Flame Plated skiving knives have also shown outstanding increases in life.

On abrasive wear applications even more remarkable results have been achieved. Practically any surface can be Flame Plated—ceramics, plastics, light alloys and non-ferrous metals as well as steel.

The Process

Flame Plating is a unique process of applying an intensely hard skin of tungsten carbide to surfaces exposed to wear or abrasion. At the Union Carbide plant at Warwick, tungsten carbide powder is 'fired' by an oxyacetylene detonation in a 'gun' and projected onto the surface to be plated. However, the temperature of the workpiece never exceeds 200°C, and therefore no metallurgical disturbance takes place. It forms a wear resistant skin from .001 to .01 in. thick. Flame Plated components like gauges, core rods, drills, taps and cutters of all kinds have their working life multiplied up to 50 times.

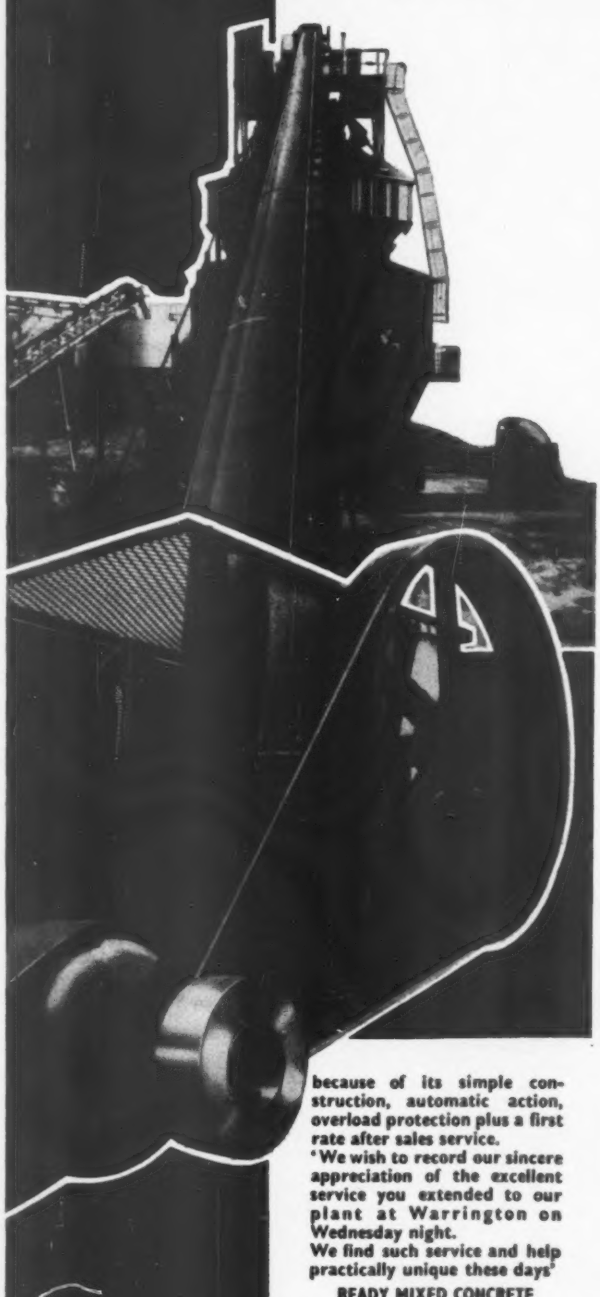
Union Carbide's qualified application engineers are available for an on-the-spot discussion of the possibilities of Flame Plating to relieve your wear problems. If Flame Plating will help your production plans, please write for further information, or ask for a Flame Plating engineer to call.

The terms FLAME PLATING and UNION CARBIDE are trade marks of UNION CARBIDE CORPORATION.

UNION CARBIDE

UBC A77

Dependable in far away places



because of its simple construction, automatic action, overload protection plus a first rate after sales service.

'We wish to record our sincere appreciation of the excellent service you extended to our plant at Warrington on Wednesday night.
We find such service and help practically unique these days'

READY MIXED CONCRETE (LIVERPOOL) LIMITED.

BROADBENT
CENTRIFUGAL CLUTCHES

THOMAS BROADBENT & SONS LTD
CENTRAL IRONWORKS
HUDDERSFIELD Phone 5520/5

Ball Mills

A new British Rema publication (No. 39B) on ball mills from Edgar Allen & Co. Limited, Imperial Steel Works, Sheffield 9, gives details of constructional features and illustrates complete systems. British Rema plants have been installed extensively for widely varying industrial duties. Minerals, ores, hard and abrasive substances and many other materials are best ground in ball mills, particular advantages being their low speeds and heavy and continuous reducing action. Both open-circuit and closed-circuit plants are supplied, the former being required for certain processes while the latter are used wherever recirculation together with the use of air separators or classifiers is possible as this leads to considerable economy. Plant layouts of ball mills with both vacuum air classifiers and air separators are both illustrated.

Variable Speed Gear

A new size, F13, of their hydraulic variable speed gear is announced in a leaflet from Carter Gears Limited, Bradford 3, Yorkshire. The unit has been developed to supplement the well-known F-type range by providing a size intermediate between the F12 and F14 units. Like the other F gears it is a self-contained, positive, hydraulic variable speed drive which provides accurate control of speed under varying load conditions. It will pick up the full rated load from standstill and give smooth stepless output speed variation from input speed downwards, in either direction of rotation. The rating is 2 hp at 1430 rpm and the equivalent constant torque of 88 lb-in. at all other output speeds down to 50 rpm.

Yale Fork Lift Trucks

Four illustrated bulletins from the Yale & Towne manufacturing Company, Wolverhampton, give detailed specifications of the Super-Series 51 and three models of the Warehouser electric fork lift trucks. There are seven versions of the Super-Series 51 ranging in capacity from 3000 to 5000 lb, all of which have the magnetic Cam-o-Tactor for travel control and a master switch for smooth acceleration. The series is notable for numerous features which add to economy in operation and maintenance and which ensure safety in use. The Warehouser trucks are of 2000, 3000 and 4000 lb capacity and are of the Rider Extend-a-Load type which is compact and light in weight and stacks at a right angle in 6 ft aisles, and in the Yale tradition are designed throughout for high efficiency and ease of operation.

Shot Blasting and Spraying

Shot Blasting and Metal Spraying Company Limited, Silwood Street, London SE16, operate the useful service indicated by their title and have carried out numerous contracts in their own works and on customers' sites for many public bodies and leading companies. Recently they have issued an illustrated folder setting out the properties and advantages of their processes: copies are available on request to the address given above.

Macalloy Manual

A complete design and application manual for post-tensioned concrete reinforcement using Macalloy high tensile steel bars has been prepared by McCalls Macalloy Limited, Templeborough, Sheffield. It is in wire-bound form, and has sections on design, detailing, stressing, applications, tables, and appendices on high strength concrete, physical properties of Macalloy steel, and specification for use of Macalloy bars.

Diesel-electric Locomotive

The new 2800 hp Brush "Falcon" locomotive is operating on the Eastern Region of British Railways after some 25,000 miles of testing. Designed and made as a privately financed venture by its builders, Brush Electrical Engineering Company Limited, Loughborough, the Falcon is one of the most powerful single-unit diesel-electric locomotives available today. It is fully described in an illustrated brochure issued by the company.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Hollow Bars

A new price list of hollow bored bars up to 12½ in. o.d. has been issued by Keeton, Sons & Co. Limited, Sheffield 9. The list now includes standardized prices and deliveries for mild steel and stainless steel hollow bored bars.

Metal Filler

A new leaflet PN/40. from W. David & Sons Limited, 47/49 Caledonian Road, London, N1 gives details of the various applications of David's Isopon in factory and workshop. Isopon is polyester thermo-setting resin, in combination with glass fibre and produces material of great strength.

Steam Boiler

The Chieftain 3-pass oil-fired boiler is the subject of an illustrated folder from Cochran & Co., Annan, Limited.

Laboratory Equipment

A large new catalogue of laboratory equipment is now available from Fisons Scientific Apparatus Limited, Loughborough.

Hacksaw Blade

Particulars of the recently introduced Kerauflex shatterproof high speed steel hacksaw blade are given in a leaflet from Sanderson Brothers & Newbould Limited, Sheffield.

Automatic Milling

The Swiss "Safag" high precision automatic milling machine manufacturers have introduced a special attachment for the mass production of milling cutters, reamers, etc. A leaflet is available from Haesler Sales 4 Grange Street, St. Albans, Herts.

Artificial Resuscitation

An educational model for use in giving instruction in the "Breath of Life" method of artificial resuscitation is the subject of an illustrated leaflet from Educational and Scientific Plastics Limited, Holmethorpe Avenue, Redhill, Surrey.

Automatic Dial Timer

A new dial setting automatic timer, type "Super-Star" incorporating the proved mechanism of type "Star", but operating four sets of change-over contacts for a very wide variety of switching actions, is described in a new folder from Electrical Remote Control Company Limited, Harlow.

Control Board Numerals

Dacron (Plan-o-Matic) Limited, 32 Fitzroy Square, London, W1 have added a new unit to their rotating disc visual control system. Termed the Uni-Disc it is a self-contained plastic case with one disc which can be nested together to form groups of discs from one upwards. so facilitating mobile groups of figures or colour controls.

Hydraulic and Mechanical Presses

Weldall-Grigg Limited, 65/67, Hanworth Road, Hounslow, Middlesex, have produced a 10-page fully illustrated brochure on Weldall-Grigg hydraulic presses for cold extrusion of steel, and an 18-page fully illustrated brochure on Weldall-Grigg mechanical presses.

Everdur for Components

A useful illustrated folder is available from Imperial Chemical Industries (Kynoch) Limited, P.O. Box. 216, Birmingham 6, on "Everdur" silicon-bronze alloy. It gives physical and working properties and examples of bolts, mesh, springs and boat nails.

Forged Rings

A pamphlet from High Duty Alloys Limited, Slough, gives details of rings made by both the trunnioning and ring rolling processes.

Oil Reclamation

Particulars of a service for reclaiming used oil are given in a folder from Midland Oil Refineries Limited, West Bromwich.

Ashington (Northumberland). J. Hepworth and Son Limited, Claypit Lane, Leeds, 2. Detailed plans have been approved for a proposed clothing factory and offices near the Jubilee Estate. The architects are Matkin and Hawkins, Barclays Bank Chambers, Fawcett Street, Sunderland.

Bishop Auckland. Atcost Limited. Factory additions are proposed on St. Helen's Estate.

Chester-le-Street. British Road Services (Pickfords) Limited, London, are to erect a heavy haulage depot at Durham Road, Birtley.

Thomas De La Rue Limited. New 220,000 sq ft factory. Wimpey and Company Limited, have started on site preparation work. Plans are by Bedford and Partners, 41 Bond Street, London W1.

Darlington. Paton and Baldwins Limited. Plans have been approved for factory additions at McMullen Road. The builders are R. Blackett and Son, Bondgate, Darlington.

Houghton-le-Spring. The North-Eastern Direct Supply Company Limited, Penshaw. Plans have been prepared by Simpson H. Lawson and Partners, Emmerson Chambers, Blackett Street, Newcastle upon Tyne, for proposed mineral water factory at Penshaw.

Messrs. Charles Limited. Plans have been prepared by Mauchlen, Weightman and Elphick, 12 Saville Row, Newcastle upon Tyne, for factory additions.

Jarrow. Morganite Resistors, Limited. The contract for the erection of the superstructure for a new 56,000 sq ft factory on Bede Estate has been let to R. Bowey and Son, Limited, William Street, South Gosforth. The architects are Williamson and Partners, Holmwood Mews, Clayton Road, Newcastle upon Tyne.

Maryport (Cumberland). Lakeland Food Industries Limited. Plans for factory additions have been prepared by R. Ward and Partners, 4, Friars Court, Carlisle, and additions for Electroflo Meters Limited.

Newcastle upon Tyne. Barnova Investments Limited. Plans have been prepared for a two-storey building for light industrial purposes at George Street. The architects are M. and H. Gatoff, 26 Mosley Street, Newcastle.

Jackson Associated Manufacturers Limited, Leeds. Plans are being prepared by Stephenson, Gillis and Partners, North Street, Newcastle for factory additions at Industry Road.

Spennymoor. F. Perkins Limited, diesel engine manufacturers, Peterborough. A factory is to be built by The Industrial Estates Management Corporation, Gateshead.

Thorn Electrical Industries Limited. Factory additions are planned by the Industrial Estates Management Corporation, Team Valley Estate, Gateshead. Plans are by Fennell and Baddiley, Bridge End Chambers, Chester-le-Street.

Stanley (Co. Durham). Pinkham & Son, glove manufacturers. R. W. Bell and Co. Limited, Jesmond, Newcastle upon Tyne are the contractors for proposed factory additions. The architects are Marshall and Tweedy, 36 Blackett Street, Newcastle upon Tyne.

Sunderland. Megator Pumps Limited London. Plans have been approved for the erection of a factory at Woodbine Street. Plans are by Production Engineering Research Association, Melton Mowbray, Leicester.

Sunderland Sheet Metal Works, South Docks, propose industrial developments at Clarke Terrace.

Tynemouth. British Die Castings and Engineering Company Limited. Plans have been approved for further factory additions on West Chirton trading estate. Contracts will be let soon. The architects are G. H. Gray and Partner, 7 Wellington Street, North Shields.

Washington (Co. Durham). Gorrills Limited, tyre factors etc., Corporation Street, Newcastle upon Tyne, are negotiating for the purchase of a plot of land for industrial development.

Acton. London Fan & Motor Company Limited, 75 Park Road North, are to erect a new factory at Sterling Road.

Alfreton. Evans Bros. (Concrete) Limited, Riddings, are to make extensions to their works.

Aspull (Lancs.). British American Products Limited are to erect a new factory.

Barking. Park Stanton & Co. Limited, 72 Leadenhall Street, London E.C.3., are to erect a new factory.

Basingstoke. Mentis Limited, London WC1. A new factory is to be built at Houndsmill industrial estate.

Bolton. Wilcockson & Son Limited, Kent Street. The School Hill Works, are to be extended.

New Factories

Brighouse. Thomas Sugden & Sons Limited, are to erect a new silo at Mill Royd Street.

Bristol. Davis & Timmins Limited, 12 City Road, are to erect a new factory at Backfield Lane. The architects are J. S. Beard, Wilkins & Partners, 101 Baker Street, London W1.

Buxton. Buxton Printing Company are to erect a new works at South Avenue.

Cheadle. Brough, Nicholson & Hall Limited, Cecilly Mills. Plans have been approved for factory extensions.

Chessington. Solartron Laboratory Instruments Limited, Cox Lane, Surbiton. The architects for extensions are Eric Firman & Partners, Thavies Inn House, Holborn Circus, London EC1.

Crewe. Calmic Limited, Crewe Hall, are to make extensions to their factory.

Doncaster. Geist Manufacturing Company, 34a Spring Gardens, are to erect a new factory at Bridge Street.

Dover. Metal Industries Limited, 133 Park Lane, London W1, are to erect a new factory at Archcliffe Road.

Dundee. Bonar Long & Company Limited, East Kingsway Works. Extensions to be carried out.

Falkirk. Walter Alexander & Co. (Coachbuilders) Limited, Glasgow Road, Camelon. Plans have been approved for extensions.

Fleetwood. Associated Fisheries Limited, Sidings Road. Factory extensions are to be made.

Glasgow. Industrial Estates Management Corporation for Scotland, 3 Woodside Place, Glasgow C.3, are to erect a new factory in Shotts Street, Queenslie industrial area.

Hayes. Electrical & Musical Industries Limited, are to build a new factory at Dawley Works, Dawley Road. The architects are Wallis, Gilbert & Partners, 5 Cromwell Road, London SW7.

Hinckley. H. Orton & Son, 2 Oxford Street, Earl Shilton. Factory is to be extended.

Ilford. Advance Components Limited. The contractors for the new factory are Hammond & Miles Limited, Scrafton Road, Ilford.

Ilkeston. Ilkeston Tyre & Rubber Company, Rutland Street, are to erect a new factory at Mundy Street.

Kettering. J. W. Towell & Son Limited, Monogram Works, Stanford Road, are to erect a new office block.

Leeds. M. H. Whittaker & Son (Engineers) are to erect a new workshop at South Accommodation Road.

Nutt & Co., Broad Lane, Bramley. The Acorn Works are to be extended.

Liverpool. E. V. Davies Limited are to make extensions to their factory at Back Canning Street.

J. & R. Smith (Liverpool) Limited are to extend their works at Williamson Square.

London. Lamson Paragon Limited. A new factory is to be built at Edgware Road. The architects are Wallis, Gilbert & Partners, 5 Cromwell Road, London SW7.

Manchester. E. Roberts Engineering Company Limited are to erect new factories at Hendham Vale Works, Queens Park.

Maryport. Electroflo Meters Limited. The Industrial Estates' Management Corporation, 30 Roper Street, Whitehaven, are to extend the factory.

Pontyclun. E. M. Manufacturing Company Limited. New factory.

Portsmouth. Canada Manufacturing Company Limited, are to erect a new factory. The architects are North & Partners, The Broadway, Maidenhead.

Romford. R. & I. Connell Limited, Ashton Road, Harold Hill, are to extend their factory.

Slough. Belgrave Press Limited, Belgrave Road. The architects for the new works are W. D. Hartley, 4 The Grove.

Stroud. Barcross Limited, Bentinck Road, West Drayton. A new factory is to be erected at Ryeford.

Stretford. Gaedor Limited, 39 Cumberland Street, Manchester, are to build a new works.

Teddington. J. Jefferys & Co. Limited. The architects for the new factory are E. Hill & Partners, 22 Borough High Street, London SE1.

Wantage. Frank Cooper Limited, Victoria Works, 110 Botley Road, Oxford, are to build a new factory. The architects are Ley, Colbeck & Partners, Palmerston House, Bishopsgate, London EC2.

Aberdeen. McIntosh, Vowan Limited of Theatre Lane, furniture manufacturers, plan to double the capacity of their factory, established only three months ago.

Buckie. Associated Electrical Industries Limited have begun work on extensions to allow for an expansion of electric lamp production. Further expansion of labour force is expected.

Dundee. Bonar Long and Company Limited, electrical engineers, are to add a 70,000 sq ft extension to their 350,000 sq ft space at Kingsway starting at an early date.

Glasgow. Glasgow Corporation is planning the building of advance factories at Balmore and Queenslie, in order to attract new industry. Government support will be sought.

Perth. J. Lyons and Company Limited food manufacturers. New cold store and distribution depot at Newhouse Road (industrial estate) at a cost of £25,000.

Uddingston. Ranco Motors Limited, manufacturers of hermetic and fractional horse power motors, are planning factory extensions which will provide nearly 250 new jobs.

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THE proprietor of British Patent No. 750963, entitled "Improvements in Gauging Apparatus for Use in Machining and Grinding Operations" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 South Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent No. 753062, entitled "A method and apparatus for forming a true cylindrical surface on an elongated member, such as a crankshaft or a calender roll", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 South Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patents Nos. 711298 and 711299, entitled "Improved Plug Closure for Handholes and the Like of Pressure Vessels" and "A Gate Valve with an Improved Bonnet and Sealing Means Therefor" respectively, offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

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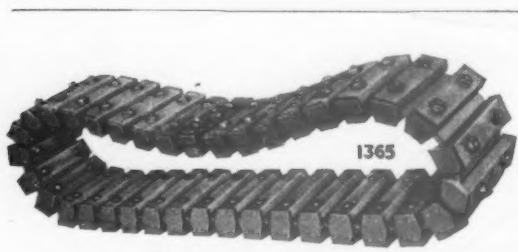

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